

Off-site Constructed housing in NSW:

opportunities and barriers for
affordable housing provision

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Summary

Despite the fact that many industry sectors have adopted smart and modern technologies to meet the challenges of the twenty-first century, the Australian residential construction industry has been hesitant to adopt off-site construction (OSC) techniques as an innovative approach to increase housing supply and affordability. This study focuses the opportunities and challenges related to OSC as a new form of affordable housing provided by Community Housing Providers (CHPs). The study examines the influences of planning and regulatory framework in New South Wales and on the ability of CHPs adopt OSC methods. The research reveals why OSC has not emerged as a cost-effective productive alternative to conventional building methods, especially for CHPs. The study focuses on the experiences of CHPs that have attempted to use OSC to provide housing to low-income households and identifies construction industry concerns about the use of OSC and the regulatory mechanism that governs this building process. As a result, the study emphasises the importance of regulatory reform to recognise OSC as a mainstream construction process, and how such recognition can benefit the construction industry in general, and CHPs acting as developers in particular.

Keywords: Off-site Construction; Community Housing Providers; Affordable Housing.

Declaration/Author's Statement

I agree to be identified as the author of this work and confirm that I have met the authorship criteria outlined in the Authorship Standard, which is included with the Macquarie University Research Code (Macquarie University 2020). Except where references are made, I confirm that there are no other authors to this publication. Prior to the start of this project, Professor Kristian Ruming and the Author received ethical approval (Reference No: 52021959426328 | Project ID: 9594 – *Appendix 1*).

Professional editing of the thesis has been conducted according to ASEP guidelines.

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Date Signed

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This study does not represent the institutional viewpoint of Macquarie University. This study received no specific funding from any public, commercial, or non-profit funding agency, and it was not influenced by any specific participant. Unless otherwise stated, the views and opinions expressed in the report are solely those of the author and participants, and do not necessarily reflect the views and opinions of the organisations represented by those participants.

List of Acronyms

ABS	Australian Bureau of Statistics
AHURI	Australian Housing and Urban Research Institute
BASIX	Building Sustainability Index
CHP	Community Housing Provider
COVID	Coronavirus Disease
CRA	Commonwealth Rent Assistance
CSHA	Commonwealth-State Housing Agreement
DA	Development Application
DAB	Design and Building Practitioners Act
EIE	Explanation of Intended Effect
GST	Goods and Services Tax
HUD	U.S. Department of Housing and Urban Development
LAHC	Land and Housing Cooperation
LEP	Local Environment Planning
LGA	Local Government Area
NAHA	National Affordable Housing Agreement
NatHERS	Nationwide House Energy Rating Scheme
NHFIC	National Housing Finance and Investment Corporation
NSW	The State of New South Wales
OECD	Organisation for Economic Co-operation and Development
OSC	Off-site Construction
QLD	Queensland
RAB	Residential Apartment Buildings Act
ROI	Return on Investment
SEPP	State Environment Planning Policies
UK	United Kingdom
US	United States of America
VIC	The State of Victoria
WA	Western Australia

1 Introduction

1.1 Research Background

In an era when globalisation, industrialisation, and digitisation are at the forefront of developing economies, it is critical that these economies pursue modern sustainable solutions in construction that meet the housing needs of a growing global population not just as a necessity, but also as a basic human right (Cox & Pavletich 2020). Despite the fact that many industries in developed economies have adopted smart and modern technologies to meet the challenges of the twenty-first century, the Australian residential construction industry has been hesitant to do so (Steinhardt & Manley 2016), with builders and developers most often preferring to offer conventional building solutions to meet their client development requirements.

Social Housing management has frequently been the responsibility of the states under the Constitution. Social Housing is frequently co-funded by the State and Commonwealth Governments under agreements such as the Commonwealth-State Housing Agreement (CSHA) and the National Housing and Homelessness Agreement (NHHA) (Pawson, Milligan & Yates 2020). Despite these funding attempts, governments at different levels have frequently used neoliberal approaches to reduce housing funding commitments and seek to shift management, and increasingly development obligations and ownerships of social housing to not-for-profit CHPs.

Following the 1970s, governments adopted a neoliberal approach, focusing on market-based solutions to housing problems where the scope of social housing was viewed differently. Social housing was no longer seen as a public good for low-income workers, but as a welfare entitlement for the most vulnerable. Given the availability of welfare contributions, it has resulted in the construction/development of social housing over the years. This resulted in only addressing the needs of the vulnerable while excluding an increasing number of people who had a genuine need for housing in urban areas that contributed towards economic progress (Compass Housing Services 2021; Raja 2017; Ruming 2018).

This necessitates the development need for a new type of housing construction that can expedite supply with the aim to improve social housing delivery, contribute to national productivity, and fuel economic development amongst a wider community (Productivity Commission 2019) (MacLennan et al. 2018).

Off-site Construction (OSC) techniques have become a mainstream residential construction technique around the world (Steinhardt & Manley 2016), that has the potential to expand the delivery of more affordable housing in Australia, if supported by appropriate policy and planning regulations. In the context of rising housing unaffordability across Australia, policy and planning regulations should aim to enable innovative forms of housing, providing choice to diverse households. It has been argued that existing housing policy and planning guidelines, at both the state and local government levels, restrict housing supply and innovative construction methods (Gilbert & Gurran 2018). As a result, there has been a mismatch between housing availability and the diverse needs for different types of housing (Grant 2020). This includes the need for social and affordable housing.

The context of this research looks at the use of OSC techniques which is a construction method that has shown to improve affordable housing delivery in some parts of the developed world (De Mendoza 2018; Thompson 2019). While there are diverse types of OSC (see Chapter 2), OSC is typically defined as the manufacturing and assembly of building elements, components, and modules within a factory for transport and installation on-site. (Ginigaddara et al. 2019).

There has been international debate over the benefits of using OSC over conventional construction methods as a solution for delivering timely and cost effective housing (Duc, Forsythe & Orr 2014), literature suggests that Australia has not been as successful as many other developed economies in its adaptation (Steinhardt & Manley 2016). Taking into account the benefits that OSC has been claimed to provide in academic and industry literature (Bertram et al. 2019; Duc, Forsythe & Orr 2014; The Modular Building Institute 2010), this research will investigate whether OSC can be used to develop social and affordable housing in Australia, with a focus on New South Wales (NSW), to understand the opportunities and challenges that OSC can present in the event that community housing providers (CHP) and their stakeholders envisage to do so.

Considering the benefits that OSC has been claimed to provide in academic and industry literature (Bertram et al. 2019; Duc, Forsythe & Orr 2014; The Modular Building Institute 2010), and the housing challenges faced in NSW this research will investigate whether OSC can be used to develop social and affordable housing in Australia. The research will draw on industry insights from other states in Australia, with a focus on New South Wales, to better understand the opportunities and challenges that OSC can present if community housing providers (CHP) and their stakeholders decide to implement OSC in their developments.

The following figure 1.1 depicts the scope of the research. As shown in the diagram on the right, the study will look at the delivery of affordable housing that meets national construction standards and can benefit social housing providers, as well as if there is an opportunity to redevelop the already ageing public housing in NSW, which will contribute to national productivity. In doing so, the research will examine government policy related to affordable/social housing and public housing on the one hand and building and planning regulations affecting the NSW residential construction industry on the other, in order to assess the influencers of regulatory reform who can enable OSC to be officially accepted as a construction method in NSW.

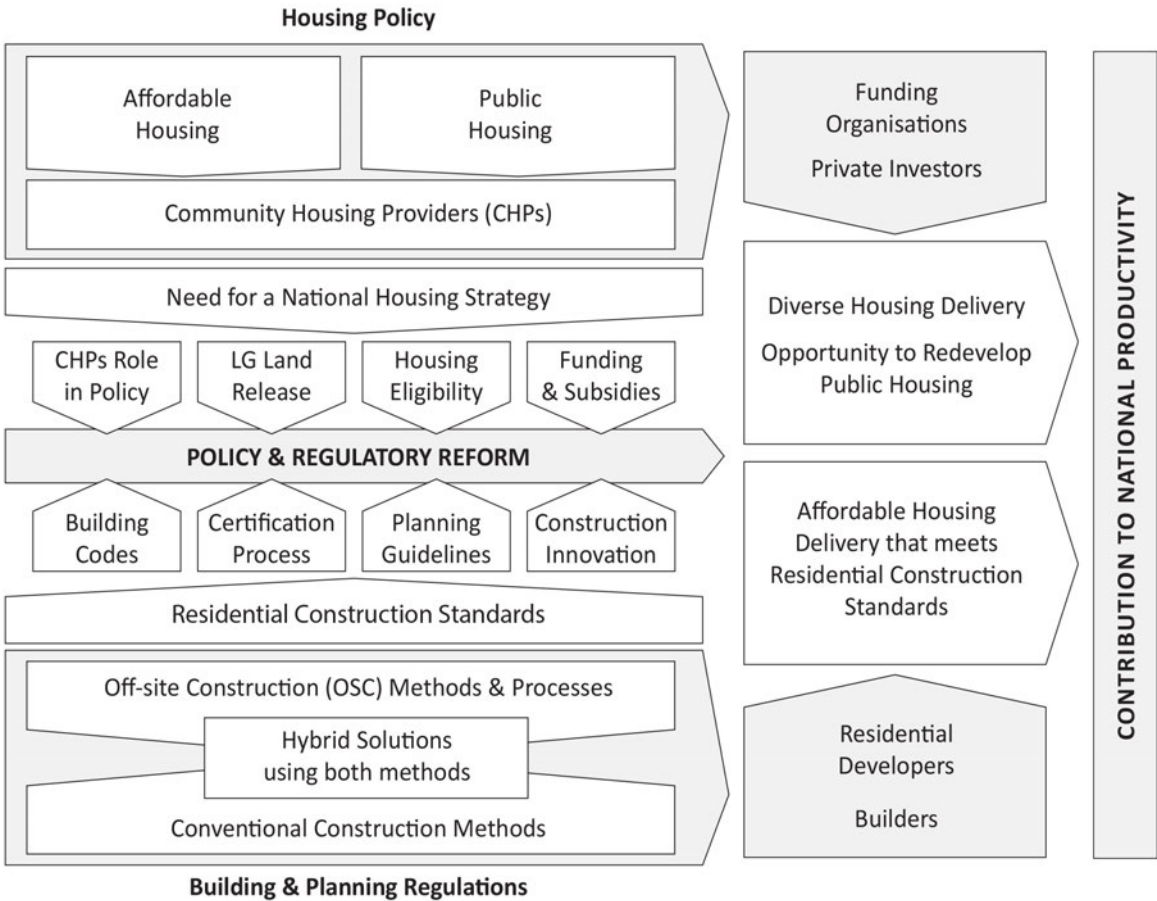


Figure 1.1 – Scope of Research

The top half of the diagram represents the community housing sector, while the bottom half represents the residential construction industry serving the housing sector in NSW. The middle section identifies areas of concern that must be addressed through reform and accredited by regulators if the benefits of OSC are to be offered by builders and developers to community housing sector in the same way that they are in many other countries (Dawkins 2011; Steinhardt & Manley 2016). The study concludes by outlining the opportunities that OSC can offer stakeholders involved in the development of community housing, as well as the responsibilities that they must accept if OSC is to be recognised as a mainstream construction method.

The research will be focused on understanding the complexities of social and affordable housing provision, as well as the opportunities Off-site Construction (OSC) can provide as a new construction method to make housing more affordable and expedite housing delivery in NSW.

1.2 Research Objective

The study will look into the question of whether OSC methods can be used by builders and developers to meet the housing needs of CHPs. While the research will acknowledge the constraints and opportunities that OSC can present in the supply of housing delivery, the primary goal will be to understand the impact that housing policy, NSW planning guidelines, and Australian building regulations have on the adoption of OSC. The study will identify if OSC can be a cost effective and time efficient alternative to conventional building approaches used by NSW developers and builders.

The research objective is to fill important gaps in academic and industry knowledge about the utilization of OSC methods in NSW for the purpose of social and affordable housing delivery. The findings will assist academics, policy advocates, government institutions, institutional investors, and the Australian construction sector, as well as any related industry bodies. The research will look into how OSC can be recognised as a mainstream construction method that can subsequently be used by CHPs to provide housing options for low-income families who are disadvantaged.

The following research questions will be addressed in this study:

1. What funding and housing delivery challenges do Community Housing Providers in New South Wales face?
2. What are the potential benefits and drawbacks of using off-site construction (OSC) for residential developments in New South Wales?
3. Can off-site construction (OSC) be a development alternative for Community Housing Providers (CHPs) in New South Wales, and what opportunities and responsibilities can stakeholders take to initiate transformation?

In addressing the questions, the project sought to highlight issues in NSW that may be applicable in some of the major states that face similar housing challenges to NSW. Attempts have been made to include materials from other states and to capture comments from research participants to provide a comparison of how other jurisdictions are addressing the use of OSC methods to solve housing problems. The fieldwork interviews directed the research towards three case studies of CHP attempts to use OSC as part of their development strategy to reduce development time and manage the cost of construction.

Finally, the research recognises the *opportunities* that OSC can bring to each type of stakeholder and the *responsibilities* they need to take if they are to promote OSC as a mainstream construction method that CHPs can benefit from (Tables 3 and 4).

1.3 Research Method

A three-pronged approach was used to establish if OSC can be a new form of construction that facilitates CHPs to provide affordable housing. First, a detailed review of housing policy and planning guidelines that regulate the development environment of CHPs when delivering social and affordable housing was undertaken.

Second, an investigation of how far OSC methods had penetrated the Australian construction industry and the extent to which they were offered as an alternative construction solution to conventional methods of construction was initiated. Using both local and international academic writings and industry publications on the opportunities and challenges that OSC offered to the residential construction industry, the review explored the extent to which attempts had been made to recognise OSC as a development alternative for affordable housing.

Third, interviews were conducted to explore the perspectives and experiences of key stakeholders involved in community housing development initiatives, ranging from housing policy advocates in the community housing sector to council planners and building regulators who govern the construction and development processes of CHPs. The purpose was to determine if OSC could be used as an innovative building method by CHP looking to provide affordable housing solutions.

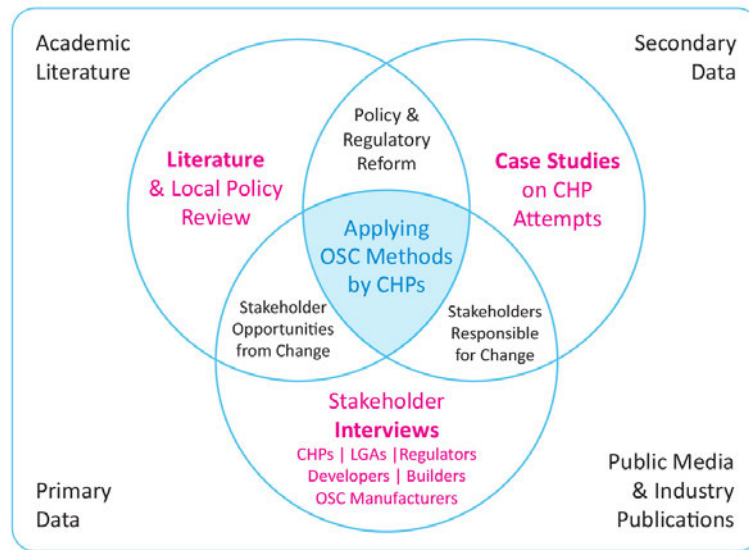


Figure 1.2 – Research Approach

Figure 1.2 depicts the research approach, in which knowledge gained from the literature was compared with interview results to determine the extent to which the opportunities offered by OSC methods had been recognised and accepted by various stakeholders. Using the snowballing (Creswell & Poth 2016) technique in interviews, the research was able to identify three case studies. In order to identify the outcomes of CHPs attempting to use OSC methods, insights from the case studies were reconfirmed through the interview process. Many countries that had adopted OSC methods, as evidenced by literature, were influenced by industry actors (Steinhardt et al. 2020). Interviews were conducted to identify stakeholders who were in charge of change and capable of driving regulatory reform in order for OSC to be accepted as a mainstream construction method.

1.3.1 Method 1 - Literature Review

The study began with a review of academic literature, both in Australia and internationally, that identified the benefits and drawbacks of using OSC methods in the construction of housing. Industry literature was reviewed to gain a better understanding of the technological advancements in this area of construction and the extent to which they have been applied to residential construction. Particular attention was paid to literature that outlined the development challenges facing CHPs and their use of OSC approaches to mitigate such challenges. There was limited publication about the use of OSC in the development of social and affordable housing. The majority of the literature was based on research conducted overseas on the use of OSC to build market housing. The literature review shaped the focus and wordings of interview questions. A more detailed analysis of literature is provided in Chapter 2.

1.3.2 Method 2 - Semi Structured Interviews

Key stakeholders interviewed for this study included persons who have regulatory knowledge and experience in delivering OSC, managing CHP development initiatives and housing policy advocacy. The research used the methodology of qualitative interviews (Maxwell 2012) to explore policy perceptions and planning experiences of three key stakeholder groups: 1) planning practitioners and regulators at local and state government levels; 2) community housing providers exploring innovative housing solution in NSW; and 3) the residential construction industry which included developers, builders and a manufacturer specialising in OSC housing.

Twenty stakeholders were identified and invited to participate in this project, of which sixteen participated in in-depth interviews. A list of stakeholders interviewed for this study, with their respective sector roles, is provided in Table 1.1. The sampling technique used in selecting the stakeholders was non-random but purposive. The interviewees were chosen from the three specific groups mentioned above relating to their area of expertise. Initial participants were identified via websites and publicly available publications. A snowball method (Creswell & Poth 2016) was employed where initial participants were asked to suggest other potential participants.

Stakeholders	Sector	Role	Jurisdiction	Area of interest
Housing Policy Advocate	Industry Body	Policy	NSW	Social Housing Policy
CHP Participant 1	Tier 1 CHP	Developer	NSW	Social & Public Housing Mgt.
CHP Participant 2	Tier 1 CHP	Strategist	NSW/QLD	Social & Public Housing Mgt.
CHP Participant 3	Tier 1 CHP	Developer	NSW	Community Housing
CHP Participant 4	Tier 1 CHP	Developer	NSW	Affordable Housing
CHP Participant 5	Tier 1 CHP	Developer	NSW	Social & Public Housing Mgt.
CHP Participant 6	Tier 1 CHP	Developer	NSW	Social & Public Housing Mgt.
CHP Participant 7	Tier 2 CHP	Developer	NSW/ACT	Social & Affordable Housing
Council Participant 1	Inner City LGA	Planner	NSW	Involvement with CHP's
Council Participant 2	Inner City LGA	Accessor	NSW	Development Assessment
Council Participant 3	Outer City LGA	Accessor	NSW	Development Assessment
Council Participant 4	Outer City LGA	Planner	NSW	Rural Council's Approach
Tier 1 Developer 1	Developer	Developer	NSW	Govt. Property Developer
Tier 1 Developer 2	Developer	Developer	NSW/Global	Private Property Developer
Building Industry Regulator	Regulator	Regulator	NSW	Construction Industry
Off-Site Manufacturer	OSC	Manufacturer	NSW	Off-site Manufacturer

Table 1.1 Stakeholder Interests and Roles

These stakeholders come from a range of locations in NSW and fit the role of being industry actors as those involved in residential development, either through housing supply side contributions or by regulating the building industry. All participants had experience in OSC construction, CHPs management and development or housing policy in NSW, although a few also had interest/experience in other states. State planning authorities and the body representing Australia's off-site construction industry did not respond to the invitation to participate. Despite showing some interest, existing developers who were currently involved in OSC were hesitant to participate or disclose their involvement with OSC methods.

Potential participants were contacted via an email (*Appendix 2*). The body of the email provided a brief description of the research, and an invitation to participate. The participant information/consent form included a set of indicative interview questions (*Appendix 3*). All

interviews were conducted electronically (e.g., via Zoom or MS Teams) at a time convenient to the participants with the shortest being 35 minutes and the longest being less than an hour in duration. The research was approved by the Macquarie University Human Research Ethics Committee under the approval number 52021959426328.

Data for this research was collected using structured open-ended interviews. To increase the comparability of responses, similar wording and sequence of questions were used in the interviews. However, questions were adjusted depending on the circumstances and area of expertise of the person being interviewed. During the interview the questions were amended and rephrased to also improve clarity and conversational flow of the interview. The structured open-ended interviews did not constrain participants but gave them opportunity to share their thoughts and experiences in as much detail as they preferred. The interviews were transcribed and analysed using NVivo.

1.3.3 Method 3 - Case Studies

Rather than being a method, case studies are a broader methodological approach to research design in the subject of geography and planning (Hay 2016). In this research, case studies were used to explore attempts made by CHPs to use OSC methods in their developments. The use of case studies helps to explore in depth nuances of the phenomenon and the contextual influences and explanations of that phenomenon (Gerring 2004). Case studies when used as a research methodology can include a combination of qualitative and real-life situation analysis. The study had no intention to create a statistical generalisation by emphasis on numbers but was aimed towards understanding how the phenomena is manifested in CHPs attempting to use OSC, despite industry reluctance. While a cross-case comparison of different OSC affordable housing initiatives used internationally was conducted, an analysis in the form of interviews was conducted on the three case studies that were attempted by housing providers.

The three case studies attempted included a completed project using OSC, a failed attempt to use OSC, and a final attempt where the development objectives were misaligned with the OSC method to be used. These case studies help to understand how OSC as a solution can provide CHPs with the opportunity to provide affordable housing to underserved communities.

2 Literature Review

2.1 Introduction

This research was motivated by literature and media reports (Daley & Coates 2018; Raja 2017) that showed how housing had become so financialised that it was no longer a basic human right, resulting in the severity of Sydney's housing problems.

According to the 16th Annual Demography International Housing Affordability Survey of 2019, Sydney is the world's third most expensive city for housing (Cox & Pavletich 2020). There is also literature arguing that the socioeconomic and demographic disparities across different regions of Sydney, a city recognised for its diverse demographic and socioeconomic mix, necessitate the need for regionally balanced housing policies that reduce unaffordability (Bangura & Lee 2019).

The investigation of off-site construction (OSC) as a solution for affordable housing was prompted by two pieces of literature: one on how off-site construction methods have converted projects into products in the construction sphere (Bertram et al. 2019), and the other on how OSC methods have been used in the delivery of affordable housing in the United States (Thompson 2019) by the United States Department of Housing and Urban Development initiating reform to "manufactured homes," a term commonly used for OSC housing in the U.S (Dawkins 2011).

2.2 The gap in research

Surprisingly, on seeking evidence of attempts made by CHP to adopt OSC in Australia, there was no evidence in the literature that the commonly published OSC characteristics found in both the academic and industry literature were being used by developers or builders, or even encouraged by industry regulators, to supplement the delivery of affordable housing in Australia. This gap in research compelled the start of this study.

2.3 The need for housing and CHP provision

In the global context, based on a survey conducted by McKinsey in 2014 there is a requirement for 440 million housing units by 2025. In developed economies policy makers and planners may consider this to be a daunting task. It was observed that with the support of proper government policy and regulatory reform backed by supportive infrastructure the development of affordable housing can offer tremendous opportunity for private sector organizations in the construction industry. It was found that the investment needed to close this global affordable housing gap is around \$9 trillion to \$11 trillion for construction alone. The study predicts that the investment in affordable housing can provide productive opportunity for developed nations through employment. The investment in such development can also level some of the inequalities created by finance sectors in advanced economies (McKinsey 2014).

A literature review was conducted to determine whether Australia as a whole was experiencing a housing crisis. Demography International's annual surveys on Housing Affordability and periodic commentary from the Grattan Institute reveals a growing concern about housing unaffordability in Australia's major cities, with Sydney named as one of them (Cox & Pavletich 2020; Daley & Coates 2018). Housing affordability typically refers to the relationship between expenditure on housing (prices, mortgage payments or rents) and household incomes (Australian Institute of Health Welfare 2020).

To some, housing has become a mode to secure and accumulate wealth, rather than it being an affordable place to live in dignity, to raise a family, and thrive within a community (Farha 2017). The financialisation of housing can be an impediment in the realisation of housing as a basic human right (Pawson, Milligan & Yates 2020; Rydin 2020). Leilani Farha, a special rapporteur to the UN on adequate housing in an interview with the Guardian stated that. "Financialisation has robbed housing of its function as a social good. In financialised housing markets, housing is no longer 'people- driven'. Decisions about housing – its use, its cost, where it will be built or whether it will be demolished – are made from remote board rooms and by individual investors with little if any consideration of the outcome," (Raja 2017). The statement by Farha indicates that there is a weakness of governance in economically developed countries where the absence of proper policy and planning reforms have made financial systems grow exponentially over the purpose of housing systems. Many studies have found that housing, whether private or

community-based, plays an important role in a country's productivity and *real* wealth generation. (Farha 2017; Infrastructure Australia 2019; Productivity Commission 2019).

In a speech to a business summit organised by the Australian Financial Review in 2019, the governor of the Reserve Bank of Australia sounded more supportive of the concept of capital gain, which promoted the financialisation of assets, raising concerns about housing affordability (Lowe 2019). The Governor's remarks suggest that housing has become a financialised and debt-fuelled speculative asset class, with prices decoupling from households earning moderate to low incomes. In effect, the slogan "Let the market decide" used by some policy advocates reinforces the fact that the market has become the policy (Randolph 2020).

Despite the fact that the Commonwealth and State governments in Australia have implemented a variety of interventions to regulate the housing market and reduce unaffordability, little effort has been made to increase housing delivery. In their book Pawson, Milligan and Yates (2020) carefully document compelling evidence on the failures of the Australian housing system and how a shortage of social and affordable housing has been allowed to develop (Pawson, Milligan & Yates 2020).

In their book Pawson, Milligan and Yates (2020) examine how Commonwealth housing responsibilities have been transferred to community housing providers through the use of State housing jurisdictions, which highlights the systematic dilution of public housing responsibilities by the Government. In this context, the outcomes of the NSW public housing asset management transfer model were examined in literature to determine if the public housing transfer provided opportunities for future potential growth or slowed the progress of community housing providers. In a recent study conducted by the Australian Housing and Urban Research Institute (AHURI) as a key point have highlighted that the social housing sector is seriously constrained in its ability to maintain, renew and configure stock to meet current and future demand (Sharam et al. 2021).

Attempts were made by the Organisation for Economic Co-operation and Development (OECD) to review Australia's social housing needs, to know if NSW and Australia as a whole were keeping up with international trends on the existing and future needs of social housing against other OECD member countries. The findings are discussed in the context of knowing how many houses would need to be built to keep up with OECD accepted averages (see section 5.1).

Despite the funding and housing delivery challenges that CHPs in NSW face (Compass Housing Services 2021) AHURI's study claims that CHPs are seriously constrained in their ability to maintain, renew and configure stock to meet current and future demand in housing. The report argues that the maintenance backlogs in both the public and community sectors are causing unacceptable conditions for many tenants. Some of the backlog is so severe that it necessitates the early disposal of assets, financial losses, and a reduction in provision during times of increased demand (Sharam et al. 2021).

Ruming (2016) highlighted the opportunities and challenges presented by the current government-led social housing transfer initiative (Ruming 2016). Ruming saw an opportunity for CHPs to gain a new housing identity, which aided in attracting private financing and growing the community housing sector. Ruming acknowledges in his study that for many CHPs, reduced State funding and the lack of a coordinated social housing policy can limit the opportunity to secure private finance that can fund new housing, resulting in development challenges for CHPs. Despite these obstacles, attempts were made to support the view that ownership of these public housing assets must be transferred to community housing providers if they are to provide social good. This argument was frequently compared in literature published to similar approaches used in the United Kingdom (Newman 2021). Although CHPs have been burdened with these depleted public housing assets some policymakers and advocates still place their hopes in an emerging non-government affordable housing industry that is centred around not-for-profit CHPs (Pawson, Milligan & Martin 2019).

In identifying the different revenue streams that CHPs had access to, industry literature and published information available online posted by government agencies and institutions were considered. The contents were examined in order to determine what types of funding was available for new developments and if there was any assistance the Commonwealth government provided in the form of development subsidies to CHPs to manage new developments. A study conducted by AHURI (Lawson et al. 2018) found that a capital grant model supplemented by efficient financing provided the most cost effective pathway for CHPs. A study conducted by Equity Economics (Equity Economics 2021) to define the role of community housing in meeting NSW's future housing needs discovered a significant and growing need for investment in social and affordable housing in NSW. The investment requirements were calculated using OECD data on social housing (OECD 2019). According to Equity Economics, a lack of investment in social

housing over the years has resulted in a significant drop in social housing relative to population, and with housing unaffordability on the rise, a \$2.2 billion investment per year over the next 30 years is required in NSW. Based on a development model, Equity Economics claims that engaging CHPs can reduce government costs, making them an ideal candidate for an innovative building approach. The NSW Government currently delivers social housing directly through the Land and Housing Corporation (LAHC) and the Department of Communities and Justice (DCJ), as well as in collaboration with CHPs (Barnes, Writer & Hartley 2021).

There have been numerous academic comments in the context of urban studies about the planning challenges (Kendall & Tulip 2018; Productivity Commission 2019) faced by developers when developing market housing. Following a review of these commentaries in literature on planning, it was discovered that there was little content that delves into evaluating the planning influence on community housing developments (Gilbert & Gurran 2018).

Apart from market housing developments many social and affordable housing properties have been built in local government areas identified by the NSW Government, financiers, infrastructure bodies, and economic forecasters as critical hotspots for economic growth and productivity (Productivity Commission 2019). Regardless of where these hotspots are located, local plans frequently govern residential development in Australia, where there is a great deal of concern about housing supply and affordability (Gilbert & Gurran 2018). Gilbert and Gurran examine how legally enforceable development controls limit diverse and affordable housing development.

In terms of community housing developments, it was discovered that in recent years, media articles have highlighted the shift in local government planning brought about by the State's implementation of SEPP 70 (NSW Legislation 2019) which is further discussed in section 3.3.2. This was a planning tool used in New South Wales to identify the need for affordable housing in certain local government areas.

2.4 Off-site construction (OSC) maturity

After the second world war during an era of fascism's modernist revolution the concept of off-site building was inspired to be a timely solution for housing. With devastations from the war, Europe was forced to use its military grade manufacturing facilities to construct houses for

displaced low-income families. Today the concept of off-site construction has developed into parts of Europe and some Scandinavian countries being pioneers in the use of offsite manufacturing techniques in the 21st century (Halman, Voordijk & Reymen 2008)

Off-site Construction (OSC) methods were referred to using a variety of terms in the literature, with the terms prefabrication and modular becoming more popular in the last decade. The use of various terms in academic literature was found to be influenced by industry journals and publications that were written by industry experts who referred to it based on the stage of construction completed or by the proportion of manufacturing that was being done off-site and the level of completion/assembly required onsite. The most commonly used terms were components, panels, pods, modules, and 3D volumetric units (Bertram et al. 2019). In this thesis, the terms pods and volumetric units will refer to completed building units that will be moved in unit blocks and placed alongside one another onsite to complete a building development project. The term Off-site Construction (OSC) was chosen for the study based on a recent academic study on OSC Typologies (Ginigaddara et al. 2019) conducted in Australia.

Literature highlighting how parts of Europe were rich in timber resources and had the reach to other parts of the continent by road gave them the opportunity to be industry leaders in using OSC methods (Halman, Voordijk & Reymen 2008; Oti-Sarpong et al. 2021). In literature Japan was frequently credited with combining the efficiencies of lean manufacturing used in the automobile industry to improve housing construction. A study conducted in the adoption of OSC by country context done by Steinhardt (Steinhardt et al. 2020; Steinhardt & Manley 2016) stood out in the review as it included an analysis of Australia and other countries such as Japan, Sweden, Germany, Netherlands, United States and The United Kingdom who had similar housing problems.

Steinhardt's observations were that developed nations had an infrequent application of OSC methods in housing and had identified Australia as one such country. Steinhardt found that although Australia allowed the identification of OSC there was limited reform that enabled its application (Steinhardt et al. 2020). Australia was identified to have limited information and publication on industry data relating to OSC. There was reference in Steinhardt's study to the Manufacturing Excellence Taskforce of Australia (META) where in 2014 they had estimated a continuing low uptake of approximately 3% of OSC on all new housing in Australia. Steinhardt suggest that the relatively small OSC housing industry can be a reason for low OSC adoption and

is evidence that large industry is a 'necessary but not sufficient' factor to enable experimentation OSC methodologies. Based on the review Steinhardt's paper the research sees an opportunity to dwell on the needs of CHPs to deliver social and affordable housing as a trigger for experimentation OSC methodologies in Australia.

Steinhardt concludes by saying that the structure and dominance in industry actors play a crucial role in the adoption of OSC methods. In a review conducted by PrefabNZ (De Mendoza 2018) OSC housing remains a minor component of the residential construction industry in Australia, with its strengths resulting in niche or specialised residential builds (e.g., mining camps, rural housing, and 'granny flats') and non-residential portable structures (e.g., site offices, remote hospitals).

There was evidence of initiatives being undertaken in neighbouring New Zealand to carry out policy reform that recognised OSC as a mainstream construction method for delivering housing (The New Zealand Government 2021).

“We are bringing building consenting processes into the 2020s to make the most of industry innovation and modern technologies. Offsite manufacturers have an important role to play in delivering the modern, healthy homes we need” (New Zealand Construction Minister Poto Williams).

Despite limited recognition by the Commonwealth and State Governments and with no planning references to the usage of OSC methodologies, OSC has been mentioned in recent government papers (Economics References Committee 2015; NSW Department of Planning 2020; The Affordable Housing Working Group 2016). Some of them allude to OSC as a development strategy for affordable housing, while others such as the design guide for development applications suggest architectural views on how OSC can facilitate more housing diversity by advocating different housing development designs (Department of Planning and Environment 2018).

In recent years, concerns about rising labour shortages (Watson 2012) and construction costs (Arcadis International 2020) in Australia have been used by the construction sector to highlight the global uptake in using OSC as an alternative construction method. OSC is seen to be competitive and efficient, as parts of the construction industry have moved towards

manufacturing off-site to take advantage of some of the characteristics that a lean manufacturing process can offer (Barlow et al. 2003; The Modular Building Institute 2010).

Often construction was compared to many other industries that were built around manufacturing principals such as continues improvement and process efficiencies (Duc, Forsythe & Orr 2014; Goulding & Arif 2013).

Industry advocates and experts argue for a shift from conventional construction methods to off-site construction processes. The literature from the industry ranges from outlining a vision (Hampson & Brandon 2004, 2020) for the construction industry, of which OSC is a component, to proposing OSC as a modern method of construction for housing delivery. There is recent evidence that industry bodies and universities are reviewing the regulatory barriers associated with the adoption of OSC methods in collaboration with the Housing Industry Association (Gad et al. 2021), the peak national industry association for residential construction and development.

Despite the fact that OSC was frequently mentioned in literature as being used to manufacture portable structures and temporary accommodation in Australian caravan parks, there was little mention of OSC being used in multi-story developments in Australia. This is in contrast to a research paper published on post-war residential developments in Western Australia (Taylor & Gregory 1992), where a well-known architect named Harold Krantz used imported OSC components to build a multi-story residential development in Perth. Since then, there is very limited mention in literature about the adoption of OSC methods for residential developments in Australia.

In recent years, there has been media coverage of the use of OSC methods on large residential building projects (OECD 2021) initiated by the United Kingdom government and private sector in an effort to provide affordable housing (Newman 2021). The \$480 million investment, which will be used to build 600 new and 600 refurbished properties, will use OSC since it will allow for shorter construction timeframes, less disruption to the local community, and reduced construction waste on site. Despite these efforts to use OSC techniques, there have also been media publications that have dealt a blow to the OSC industry both globally (Tabet 2021) and in Australia (Bleby 2018).

According to media reports, the demise of two organisations which were lauded as technologically advanced in following modern construction methods, had caused a shockwave

to the construction industry who were already contemplating to use OSC techniques. As industry advocates commented on the failure of the Australian company, they stated that it was all about how the project was executed, claiming that the company's traditional practises in the delivery of a modern product had worked against them.

The global fall of a US\$ 3 Billion start-up company was the direct result of the closure of construction sites due to the pandemic. Some industry experts were of the view that the company misjudged their investments and thought that they could save time and money by bringing every step of the construction process in-house (Tabet 2021).

In essence, there is evidence that housing, whether private or community-based, plays a significant role in a country's productivity and real wealth generation. There was evidence in the literature that Australia as a whole was in the grip of a housing crisis. According to the literature, the government's systematic dilution of public housing responsibilities over time resulted in reduced State funding and a lack of a coordinated social housing policy, limiting CHPs' ability to secure private finance to fund new housing. This was compared to literature based on some of the UK's approaches.

After the 1970s, there was little evidence in the literature of the Commonwealth government providing assistance to CHPs in the form of development subsidies to manage new developments. Evidence suggests that in Australia, where there was much concern about housing supply and affordability, Local Government plans frequently governed the growth of residential developments, fuelling the financialisation of housing as an asset.

Many researchers agreed that there was a great need to make housing affordable, and there was very little emphasis in Australia on development efforts made when many other countries embraced new technology and innovations, such as OSC, to improve housing supply and affordability. Steinhardt (2020) argued that, while Australia permitted the identification of OSC, there was little reform that enabled its application. With CHPs agreeing to maintain a depleted public housing stock and a growing need for affordable housing, this study investigates whether OSC methods can be a solution for CHPs and what had prevented them from doing so.

3 Housing Development challenges confronting Community Housing Providers

3.1 Introduction

This chapter explores the changing status of social and affordable housing in housing policy. It looks at the transfer of housing responsibility from the State to Community Housing Providers (CHPs), and the challenges faced by CHPs in their efforts to provide social and affordable housing in the face of growing demand in NSW. The housing development challenges confronting CHPs were broadly identified in the context of literature and sector publications. This data was used to create the framework for the field study, which included interviews with community housing sector professionals and housing industry regulators. Drawing on the views and experiences of CHPs and regulators, the chapter investigates whether the management transfer of public housing has provided opportunities or challenges for CHPs looking to develop new housing stock. The chapter identifies the factors that drive CHPs to use costly building methods to deliver new housing stock to eligible clients in context of current economic conditions and tightened funding arrangements (Lawson et al. 2018). In response to the challenges that CHPs face, the chapter investigates whether an innovative building approach, such as offsite construction, can assist CHPs in their efforts to develop new housing stock to address some of NSW's housing challenges (Steinhardt & Manley 2016).

3.2 The undervaluing of Social & Affordable Housing

The free-market ideology of “let the market decide” mobilised by successive Commonwealth Governments, influenced by neoliberal views on housing (Compass Housing Services 2021; Pawson, Milligan & Yates 2020), has harmed the efforts of CHPs to deliver new housing stock. As one CHP participant stated:

“It was part of a small state ideology to get rid of social housing and leave it for the market to decide. The governments gave up any responsibility to house the poorer sections of the population and let the market decide”
(CHP Participant 2).

However, the neoliberal approach of the Government had proven ineffective when new supply of housing was needed (MacLennan et al. 2018). The competitive (market based) housing market system has created inequalities in society, increasing the demand for social and affordable housing (Pawson, Milligan & Yates 2020).

Acting to support private sector housing (private home ownership and private rental), Commonwealth Governments have sought to distance themselves from social housing responsibilities, devising policies that delegated these responsibilities to state and local government (LG) jurisdictions, managed and funded through mechanisms such as the Commonwealth-State Housing Agreement (CSHA) and National Affordable Housing Agreement (NAHA). By delegating housing responsibility to states and limiting their commitment to agreements and funding allocated to each state, the Commonwealth Government has failed to create growth targets on what needs to be done nationally:

“From about the 90s onwards, we've seen a decreasing investment in terms of what has come down from the whole purpose of what social housing was being built for” (Housing Policy Advocate).

“With ownership on the rise there was a gradual shift in perception from housing working class families to the housing of people in need. Government attitude particularly in Anglosphere nations that housing was a form of welfare and not the right of a citizen” (CHP Participant 2).

The gradual decrease in investment has led to the neglect of housing (both maintenance and new supply) for disadvantaged populations that are increasingly in need of housing support. In the context of depleted state of public housing stock and the absence of a national initiative to develop social housing, State Governments rely on houses that were built as part of massive building programs from the 1950's to the 1970's to act as a residue for social housing. Recent efforts to fund/develop new supply have received mixed reviews. For example, CHPs claim that the establishment of the National Housing Finance and Investment Corporation (NHFIC) to fund the developments of social and affordable housing as an alternative for capital subsidies has proven inefficient:

“Funding directly is the most efficient way rather than channelling them through various organisations such as the National Housing Finance and Investment Corporation (NHFIC) making the mechanism more complex and inefficient” (Housing Policy Advocate).

There has been little initiative taken to address housing needs based on population growth and demographic change. Few jurisdictions have published information on expected demand for social housing and the strategies they plan to adopt in meeting future demands that are beyond the current waiting list (Productivity Commission 2017). The absence of a national housing strategy and the under value of the need for social and affordable housing has resulted in each State and Territory developing their own regulatory and funding frameworks.

For some key stakeholders the shortage in social housing supply is seen to result from a weakness in national policy rather than an issue of provider capacity (Pawson, Milligan & Martin 2019):

“Our members want a National Housing Strategy that will articulate growth targets on what needs to be done nationally to address housing supply based on population growth and demographic change. Will this change happen in the current political context? No” (Housing Policy Advocate).

“Policy moved towards promoting home ownership. The federal Government does not believe in a National Housing Strategy” (CHP Participant 2).

Housing Policy Advocates are of the opinion that an increase in housing supply is not a panacea for the delivery of affordable housing needs. They blame market speculation and regulations that favour market housing (as a financialised asset) for inflating house prices in NSW:

“Policies supporting first home buyers into the market sadly has only been an artificial inflationary mechanism” (Housing Policy Advocate).

The commoditisation/financialisation of housing in many countries has led citizens to experience foreclosures and evictions during times of economic uncertainties (Raja 2017) putting the strain on an unprepared community housing sector.

The long-term decisions by Government (especially the Commonwealth Government) to underinvest in social and affordable housing could be attributed to the political unattractiveness of a minority voting base that represents housing-affected voters (Daley & Coates 2018). Some argue that the shortage in social and affordable housing supply can be the result of decades of under-investment by the Commonwealth and State Governments (Equity Economics 2021; Pawson, Milligan & Yates 2020).

Despite these overarching policy and finance constraints, CHPs have emerged as providers of social and affordable housing. The research will look at some of the issues that CHPs have faced, as identified by participants.

3.3 Challenges facing CHPs in supplying social and affordable housing

This section will detail four common obstacles that CHPs face while attempting to provide social and affordable housing.

3.3.1 Challenge 1: The diminishing role of CHPs in framing policy.

Despite the fact that the Commonwealth sees CHPs as a significant developer of social and affordable housing in NSW, there is a lack of clear strategy enacted by the Commonwealth Government to enable this to happen (Milligan et al. 2015). CHPs are increasingly being asked to provide housing, but they have limited ability to influence policy discussions about the supply of social and affordable housing:

“There a strong disconnect from a policy advocacy standpoint with the government, and as a peak body as we are not involved in the national context. Unless there is change of government it will only be like the regular sound of crickets” (Housing Policy Advocate).

Similar to the United Kingdom the Australian Government's indirect practice to apply austerity measures using legislation, policies, and strategies to suppress public spending by reducing the eligibility for housing has arguably transformed the functions and limited the potential of CHPs.

"Australia is lagging in the provision of social housing. Due to the austerity policies UK practiced in the last 10 years, there's a whole Government strategy called "Leveling Up" that picks up the poorer sections in the economy" (CHP Participant 2).

Governments in power have often promoted home ownership to act as a safe haven for economic security and wealth accumulation for a privileged few causing inequality in society. Policies based on these underlying principles have frequently neglected the potential of CHPs, leaving them out of crucial housing policy decisions, resulting in a rising disparity between those who own and those who do not:

"This sector has a lot of potential. As a not-for-profit organisation we don't use the corridors of power as the private sector does" (Housing Policy Advocate).

"In time CHP's hope to have greater presence to resolve the housing affordability crisis in Australia. CHP's aim to get to a point of scale and growth where favourable conditions can fall in place" (Housing Policy Advocate).

Despite their limited role in contributing to national and state policy decisions, the expectation that CHPs will provide social and affordable housing in the future has been thrust upon them by State and Commonwealth Governments who see them as part of the solution to the housing problem (Pawson, Milligan & Martin 2019). CHPs believe that the uncertainty of having a supportive policy is one of the reasons why the community housing industry and its members are unable to scale up operations, despite the fact that members believe there is untapped potential and more innovative approaches to housing delivery.

3.3.2 Challenge 2: The varying Local Government planning guidelines.

As there are no specific state planning guidelines for the delivery of community housing, CHPs have been subject to varying degrees of scrutiny from local councils on their development projects. Despite the fact that affordable housing is a strategic objective of many councils, many CHPs are challenged by place-based local planning legislations that take precedence over State Environment Planning Policies (SEPPs):

“There are 42 different local planning scenarios that challenge developers while new powers provide every council to make it a little different. SEPP’s explanation of intended effect (EIE) clause made SEPP weaker, making Local Environmental Planning (LEP) to take precedent” (Tier 1 Developer 1).

The Commonwealth's shifting stance on social housing, as well as the State's push for affordable housing, has entrusted the responsibility of housing supply to Local Government via local planning provisions. The implementation of the *SEPP 70 Affordable Housing Revised Scheme* (NSW Legislation 2019) is one example of a planning policy that seeks to contribute to the supply of affordable housing in NSW (Pawson, Milligan & Yates 2020).

SEPP 70 was first implemented in 2002 in response to the Meriton Apartments decision, in which the Green Square Affordable Housing scheme was successfully challenged in 2000. Since then, the Urban Development Institute of Australia (UDIA NSW) has criticised the scheme for doing more harm than good to affordable housing supply, calling it premature, misguided, and inequitable ((UDIA) 2018; Morris 2021). In the case of 'Affordable Housing,' the new home buyer neither creates nor benefits from the provision of 'Affordable Housing,' as the cost of contribution is passed on to the end purchaser or land seller by the developer. The flaw in policy necessitated a revision of the SEPP 70 Scheme.

With the revision the state has recently provided Local Governments with planning leads that allow councils to demonstrate some level of receptivity towards CHPs. Despite this, the SEPP's explanation of intended effect (EIE) clause allows Local Environmental Planning (LEP) to take precedence over SEPP, granting Local Councils the authority to make choices in their best interests.

“So, you see some inner and middle ring councils taking up some of the responsibility while the others are definitely interested in passing the responsibility to other councils and stakeholders. The passing of responsibility between councils is only a small part of the picture when compared to the commonwealth government who flags housing as a state responsibility” (Housing Policy Advocate).

Housing Policy Advocates believe that some Local Governments are reluctant to partner with CHPs due to the stigma associated with community housing and shy away from taking responsibility for housing in their areas. Despite the stigma, the research found that many councils had embraced SEPP 70 and partnered CHPs to develop affordable housing, with the NSW Government authorised a selection of local councils to develop affordable housing under SEPP 70 (NSW Legislation 2019; Pawson, Milligan & Yates 2020). Eligible local councils are required to submit proposed amendments to their Local Environmental Plans for state government approval to accommodate social and affordable housing. Nevertheless, other local councils remain hesitant to partner with CHPs to provide social and affordable housing.

For most of its existence SEPP 70's application was limited to a few NSW councils (Pawson, Milligan & Yates 2020). Despite the efforts made by the State Government many of the Local Government respondents believed that there was an affordable housing crisis in their LGAs and felt that they were been constrained by the absence of proper policy directions from other tiers of government. Efforts to promote the provision of affordable housing by Local Governments were often suppressed by community outcry and influenced by financial or political concerns:

“The council will push to achieve housing targets within the prevailing strategy and political framework providing the assurance that controls will be met in achieving good design. The biggest challenge is when there is no strategy to support community concerns” (Council Participant 1).

These housing-related externalities are commonly referred to as neighbourhood effects in the literature, and they can be challenge for local governments when forming partnerships with CHPs to address social and affordable housing (Pawson, Milligan & Yates 2020).

There is an existing body of literature acknowledging how Local Governments have the authority to implement planning codes in a way that provides opportunity for CHPs to develop affordable housing (Daley J 2019; Milligan et al. 2009; Pawson, Milligan & Martin 2019).

Despite the efforts of a few local governments to support CHPs, this has not been a strategy adopted by most local governments. Respondents are of the view that the Commonwealth Government should continue to fund the construction of additional social housing by the States, as well as provide incentives to the States to relax planning restrictions imposed by local governments that restrict the initiatives of CHPs to develop affordable housing:

“The challenges are the council controls that dictate the design and there is no dispensation for social and affordable housing. A community housing provider is treated the same as a private developer when trying to get a development over the line with a DA. Councils are very conservative” (Tier 1 Developer 2).

3.3.3 Challenge 3: Bridging the gap in social housing funding

In 2016, an Affordable Housing Working Group advised the Australian Senate that resolving the shortage of social housing in NSW would necessitate ongoing public investment (Economics References Committee 2015). It is estimated that 5000 dwellings at a cost of \$2.2 billion per year was required if it is to have a significant impact on the existing social housing waiting lists (Equity Economics 2021). The prevailing strategy of the Commonwealth and State Governments to minimise expenditure and leverage private sector investment for this purpose has proven unsuccessful (Pawson, Milligan & Martin 2019).

In recent years a series of programs have been introduced to address social housing needs in NSW such as the “Communities Plus” program and the “Social and Affordable Housing Fund” (Barnes, Writer & Hartley 2021; Pawson, Milligan & Yates 2020). The former focussed on the regeneration of existing social housing estates and the latter looked at directly funding CHP led development programs to increase social and affordable housing stock. By employing these State-run programmes as interventions, the Commonwealth Government developed a neoliberal-inspired model of governance to outsource housing duties to the private sector. However, the private sector has shown little interest (Infrastructure Australia 2019):

“With funding available to the NSW Government through the National Housing and Homelessness Agreement and the funding that The Land and Housing Corporation can generate as a self-funded agency has given the Commonwealth Government an unrealistic expectation that the private sector is going to deliver housing, when there are not enough private providers coming aboard” (Housing Policy Advocate).

Policy advocates for CHPs believed that if social and affordable housing services are to be delivered by CHPs, both levels of governments must jointly establish a straightforward funding pathway:

“Funding directly is the most efficient way rather than channelling them through various organisations such as the National Housing Finance and Investment Corporation (NHFIC) making the mechanism more complex and inefficient” (Housing Policy Advocate).

In a bid to improve housing outcomes the commonwealth established the National Housing Finance and Investment Corporation (NHFIC). This was an independent corporate entity that encourage investment in housing by offering loans, investments and grants to CHPs focused on developing affordable housing (Equity Economics 2021). Although it was an effort by the Commonwealth Government to reduce the pressures on housing affordability, the NHFIC funding mechanism was not considered as a housing strategy by itself that could solve the great vacuum of the need for housing. Despite issues of complexity, the establishment of NHFIC had was welcomed as an important policy development by CHPs in NSW:

“The only important policy development was the establishment of National Housing Finance and Investment Corporation (NHFIC) by the Turnbull/Morrison Governments. In the last 3 years NHFIC has helped to fund a few thousand properties” (Housing Policy Advocate).

There is the need for a proper regulatory framework to be in place to attract various sources of funding (Community Housing Industry Association NSW 2019). It was felt that the funding offered by NHFIC, and the transfer of public housing stock for management by CHPs, will not close the gap in social and affordable housing needs. The funding provided to CHPs must compensate for

high land prices through supply-side subsidies from the State, who must be willing to make planning amendments for CHPs to compensate for the increasing shortfall in funding (Hulse 2019):

“NIFIC had helped leverage some of the new developments but the funding sources for new housing is drying up. Leading up to 2021 and 2022 the housing supply from CHP’s is going to be much lower” (Housing Policy Advocate).

The drying up of different funding pathways and the Commonwealth Government’s inability to make investment attractive in the social and affordable housing sectors (Ruming 2016) have forced CHPs to use their own resources to leverage as much development opportunity made available to them:

“Currently providers use their own resources, debt financing and own equity to leverage as much opportunity available for them” (Housing Policy Advocate).

By investing in new innovative developments, CHPs have the potential to expand their operations. Unfortunately, the equity in a CHP non-profit business model makes the organization less appealing to potential investors. CHPs' growth prospects are frequently hampered by the requirement to reinvest their distributable profits and various tax exemptions (GST, land tax, and stamp duty) received in managing depleted social housing assets. Despite these funding challenges, organisations that have adopted a self-sustaining business model have been successful and have won industry recognition by qualifying for the Clean Energy Finance Corporation’s \$250 million loan programme for CHPs to create energy-efficient affordable housing (Clean Energy Finance Corporation 2017; Pawson, Milligan & Yates 2020).

3.3.4 Challenge 4: The Public Housing Management Transfer

Australia has been lagging in the provision of social housing supply, with social housing accounting for less than 6% of dwellings. A population increase of 12.6% between 2011 and 2016 (ABS) saw social housing supply to grow by less than 3% (Equity Economics 2021). The State Governments strategy to increase social housing stock is rather circuitous. Using the social housing transfer model, State Governments sought to provide revenue pathways and

opportunities to CHPs to help them increase their housing asset base (Productivity Commission 2017). The rationale behind the public housing transfer model is for CHPs to charge a higher rent from tenants, who are eligible for Commonwealth Rent Assistance (CRA), without impacting the tenants net income (Parliamentary Library Budget Review 2017-18):

“If we take the same route as the UK, there is the possibility that CHP’s will become the largest provider of social housing in Australia” (CHP Participant 2).

The NSW Government transferred 14,000 of their social housing stock to CHPs through the Social Housing Management Transfer Program that commenced in 2016. As a result, the percentage of social housing stock now managed by CHPs has risen from 19% to 32% (Compass Housing Services 2021).

By withholding ownership of these public assets from CHPs, the NSW social housing management transfer program differed significantly from ownership transfer model practiced by governments in the UK and Europe (Pawson, Milligan & Martin 2019; Pawson, Milligan & Yates 2020; Productivity Commission 2017). In these countries CHPs had the opportunity to expand housing supply by borrowing against these assets that were one time owned by the government.

In the UK a government strategy called “Leveling Up” is aimed at reducing the inequality between places by picking up the poorer sections of the economy (Newman 2021). The “levelling up” strategy identified housing as a prerequisite for economic recovery and productivity of disadvantaged places. The decision to transfer the full ownership of public housing to CHPs saw the UK government revert to its historic role by distancing itself from the ownership and management of social housing assets (Pawson, Milligan & Yates 2020):

“Management transfers have posed unacceptable risks to CHP’s especially when Government offer location transfers on a take it or leave it basis – This can be a poisoned chalice” (Housing Policy Advocate).

The end-of-life ownership uncertainty on these transferred assets has stifled the opportunity for CHPs and poses a level of risk when pursuing developments to expand operations in NSW. By the transfer of a depleted housing stock the State Government’s intention to increase CHP’s asset

base so that they may leverage financing to further expand their housing stock was seen more as a poisoned chalice than an opportunity for growing the community housing sector. CHPs involved in this program claim to have been caught unaware of the high level of maintenance that is required in sustaining these assets:

“One reason for the inquiry to be instigated was the cost of maintenance and having to use Government nominated maintenance contactors. Tenants were unaware about the maintenance responsibilities and blamed the CHPs for poor service standards” (Housing Policy Advocate).

Saddled by the conditions of transfer on these depleting assets, there is doubt if the current public housing management program in NSW can leverage additional income for CHPs for new developments. In 2013 the Australian Housing and Urban Research Institute undertook a comprehensive analysis on social housing transfers, finding that “there has been an unrealistic loading of objectives onto this one policy mechanism (Pawson et al. 2013).” The State Government's reluctance to transfer ownership of these public assets is motivated by concerns about accountability. When given the opportunity, CHPs can seek the necessary leverage to increase housing stock by borrowing against these transferred assets to invest in new developments:

“At the moment social housing stock can't be leveraged for redevelopment. As these properties are aging, we will see CHP-led redevelopment policy on LAHC-owned Land. The policy still lacks permission that will give CHP's the opportunity to redevelop at their cost in exchange for a new lease” (Housing Policy Advocate).

CHPs do not currently own these properties, and there is concern in the industry that after redevelopment of these properties by CHPs, there is a risk of transfer back to the government at the end of the management period:

“After redevelopment of these properties by CHP's there is the risk of transfer back to Government at the end of 49 years” (Housing Policy Advocate).

Based on the social housing management transfer, the government may decide to redevelop the properties or replace them with market housing at some point in the future. This constitutes a level of uncertainty and risk for CHP's. They are of the opinion that with the high cost of land in Sydney they should be provided with a freehold title or the opportunity for a new lease on these public housing properties managed by them. Using these high-cost land titles CHPs could borrow and develop extra social housing stock without incurring any on-balance-sheet expenditure or be a strain on public debt (Pawson, Milligan & Yates 2020). Therefore, CHPs must be given the opportunity for redevelopment if the Governments intentions are to increase the capacity of social housing through higher density placements.

3.4 The Case for an Innovative Building Approach

CHPs have frequently been constrained by housing policy issues and a lack of subsidies to compensate for increases in land prices and building costs. There is the need to bridge the gap between investment and return if CHPs are to develop a sustainable business model. This section explores the rationale for an innovative building approach if CHPs are to extend affordable housing delivery, meet the demand for more diverse housing, and provide solutions to possible State redevelopment project initiatives that CHPs must take responsibility for.

3.4.1 Bridging the gap between investment and return

There is the need for a cost-effective and efficient method of construction if CHPs are to bridge the gap between investment and returns. CHPs, as a sector, have benefited from receiving 25 to 30% of income support payments from the Australian Government. They also receive 100% of Commonwealth Rental Assistance in recognition of the taxation ruling that technically accepts CHPs as a private provider (Troy, van den Nouwelant & Randolph 2019). From a revenue standpoint, CHP's derive financial benefits that are not available to public housing, where rent is charged at market value in proportion to household income (NSW Community & Justice 2021).

Unfortunately, the rental income received from the management of government-owned assets does not allow CHPs to finance new developments that will expand their services to a larger group of people who are eligible for and waiting for housing. According to Infrastructure Australia, each social housing dwelling in NSW requires approximately \$13,000 per year as a government subsidy to address the funding gap of ongoing operational costs (Infrastructure Australia 2019). The community housing sector claims that despite government benefits, the

margin for CHPs remains around 2-3 percent, which is low and makes it difficult for CHPs to secure financing to purchase land and develop housing:

“The capital subsidy gap on average is around \$13k per year depending on the location in NSW. The margins of community housing providers are around 2-3% which is pretty slim” (Housing Policy Advocate).

Despite the challenges to finance developments, a sector-led study comparing the returns between LAHC and CHPs on a standard conventional development model found that although the cost was slightly higher for CHPs the revenue returns from developments was much higher than LAHC. Comparatively, the return on investment was higher for CHPs (ROI: 0.62) than LAHC (ROI: 0.48) (Equity Economics 2021).

Housing policy advocates argue that both CHPs and public housing require new construction subsidies, and that CHPs typically take on new developments only in response to funding opportunities provided by State and Commonwealth Governments. CHPs that received capital injections in the form of land, operating subsidies, and tax benefits for development have frequently demonstrated cost efficiencies and savings to the government:

“No matter who is building the property if it’s us or the LAHC still there was some sort of capital subsidy required. At this stage we can show that there is a cost saving to government by undertaking more developments with CHPs either in full or in partnership with the sector” (Housing Policy Advocate).

There is international evidence that demonstrates the use of innovative construction approaches by private and Government agencies to combat the unaffordability in housing markets (Steinhardt & Manley 2016; Thompson 2019). Given the current circumstances, where CHPs have proven to be more cost efficient in their developments than government-run organizations, the state should provide a conducive environment to encourage innovative construction methods (Hampson & Brandon 2020) that enable CHPs to justify returns on investments in order to alleviate the escalating housing crisis:

“There is opportunity for improvement in this area by considering more innovative methods of construction that can improve the affordability of housing” (Council Participant 3).

“CHPs would want to look at innovative approaches when suddenly the Government’s desire will be to see something shovel ready and built very quickly” (Housing Policy Advocate).

An innovative construction approach will broaden the strategic purpose of CHPs by allowing them to operate at a scale that will provide operational efficiencies and a return on investment, potentially generating additional housing production on a regular basis, assisting them further in providing innovative responses to defined housing needs.

3.4.2 The need to expand housing delivery and diversity

The community housing sector, from about 2013, has experienced rapid growth. Industry records indicated that by May 2020 there had been almost a fivefold growth in the building of new homes across 45 LGAs in NSW (Community Housing Industry Association 2020). In 2019 CHPs managed around 39,000 tenancies across NSW and owned \$1.7b worth of social and affordable housing assets (Community Housing Industry Association NSW 2019):

“The community housing sector within the last 7 years has grown quite a lot especially in the recent years. The challenge is that the community housing sector is not seen as a significant developer of social and affordable housing” (Housing Policy Advocate).

Innovative development techniques may enable CHPs to maintain the level of growth and diversity in social and affordable housing delivery. CHPs face the challenge of effectively mobilising their development skills, resources, and capacities in order to obtain government subsidies or attract investment to expand housing delivery and diversity through private-public partnerships (Milligan et al. 2015):

“If there were subsidies to support more construction, it would have driven innovation in construction to look at areas such as OSC provided it is the right site with the right potential” (CHP Participant 3).

CHPs should initiate innovation in order to achieve the desired levels of housing delivery and diversity. It is critical that knowledge is shared across the sector, the construction industry, and policymakers. The Commonwealth Government must recognize and encourage the initiative to investigate an alternative construction approach for social and affordable housing by promoting Local Government partnerships (Hampson & Brandon 2020; Thompson 2019) between CHPs and Developers.

3.4.3 The potential for future development opportunity

The Commonwealth Government views social housing as an annual grant given to States rather than housing seen as a component of infrastructure that promotes economic growth (Daley & Coates 2018; MacLennan et al. 2018). The Commonwealth Government's failure to recognise the economic benefits of investing in social housing has an indirect impact on CHPs' future development prospects:

“There is hope if the government continues to view housing as a part of economic infrastructure and legitimise the standing within the Government” (Housing Policy Advocate).

The Social Housing Portfolio currently owned by Land and Housing Corporation (LAHC) had been recognised by Infrastructure Australia as an economic infrastructure that can provide multiplier benefits (Infrastructure Australia 2019). Despite the fact that state governments are responsible for designing, providing, and overseeing social housing, the inclusion of social housing as a part of a National Housing Strategy can result in Federal and Local Governments assisting CHPs through funding and favourable policy settings.

A participant expressed concern that underinvestment in social assets, combined with the economic downturn caused by the pandemic, could exacerbate the need for housing, putting additional strain on issues such as long waiting lists and unanticipated maintenance costs from ageing public housing stock, forcing all levels of government to act by providing CHPs a stimulus

to expand their building and redevelopment prospects. This may necessitate the use of an innovative construction method that is both timely and cost effective:

“Post COVID there has been nothing from the Federal Government that supported social housing. Some economists claim that a stimulus package to the sector could speed up economic recovery” (CHP Participant 2).

Many State-owned public housing properties in NSW that are managed by CHPs have had poor tenant outcomes due to the deterioration of public housing stock (The Tenants’ Union of NSW 2020). Despite these flaws, a strong advocate of CHPs stated that investments by some CHPs have improved the living conditions in some of these public housing stock. The potential for CHP redevelopment of these properties has frequently been stifled due to ownership uncertainties on these publicly controlled assets, a lack of funding that can match current construction costs, and the lengthy transition period for tenants associated with conventional building methods:

“CHP’s have invested in the condition of housing stock and provided services that the Public Housing model couldn’t have achieved” (Housing Policy Advocate).

“There is the challenge of relocating these families for redevelopment. Already with the demand for social housing you will be taking their housing away and pushing them into the limited housing we currently have” (Council Participant 4).

There is a need to establish a housing renewal program focused at redeveloping older public housing estates throughout the state (Barnes, Writer & Hartley 2021; Compass Housing Services 2021). If the State Government decides to transfer ownership of these dilapidated properties, CHPs may be able to use these public housing assets to increase the development potentials of community housing by placing higher density dwellings on these properties. The redevelopment of these government held assets can also provide opportunity for CHPs to construct mixed-tenure developments that meet high energy ratings (7-star NatHERS) as well as good design standards that foster positive tenant outcomes (Compass Housing Services 2021):

“On a tenancy standpoint there's no financial compensation in any of the policy settings to rehouse a tenant that may be affected by a redevelopment activity planned by the government. The liability falls back on to the CHP” (Housing Policy Advocate).

CHPs will need to look at an innovative building approach that can be quick to build and justify the monies already invested in these depleted assets to ensure that the cost of development stacks up. The method used to demolish and rebuild these properties should be capable of minimising the cost and inconvenience to existing tenants. If innovative construction methods are to be at the heart of these developments, CHP may need to balance competing pressures from the state (funding and regulation), the market (commercial), and civil society (community and resident) (Pawson, Milligan & Martin 2019).

Limited development budgets frequently constrain CHP development objectives. CHPs have made it a development goal to consider environmentally friendly, adaptable, energy efficient, and less expensive building approaches for end users. Many CHPs believe that the repetitive characteristics of OSC will allow them to achieve these objectives. Given the ongoing funding challenges and lack of title transfer for public housing, CHP is looking for alternative methods of construction that will allow them to quickly expand their operations and bring in early payment claims from governments, bridging the gap between rising development costs and returns. If the government decides to open its coffers and transfers ownership of these depleting public housing assets to managing CHPs, tenants forced to transition will require quick development turnarounds that a conventional building process cannot provide. OSC has the potential to be a strong contender for this standard housing offering that CHPs will promote.

Given the rationale for developing an innovative building approach for CHPs, the following chapter investigates the extent to which off-site construction methods have been accepted as an onsite development strategy in Australia. This will be followed by a chapter that assesses the feasibility of CHPs using off-site methods as a development strategy for providing social and affordable housing in NSW.

4 The use of Off-site construction (OSC) in residential developments

4.1 Introduction

The construction and property development sectors are a significant part of the Australian economy, accounting for 9% of the GDP (Australian Industry & Skills Committee 2021) and 8.6% of the total workforce (Australian Government 2021). Global advancements in construction methods and technologies, combined with rising environmental concerns, have created challenges for the Australian construction industry, resulting in an increase in new construction techniques, such as off-site construction:

“Council has seen more applications of off-site and cannot turn a blind eye towards these methods. Council can’t ignore what the people want”
(Council Participant 3).

As a national initiative for future direction for the construction industry, the Cooperative Research Centre for Construction and Innovation outlined an eight-point vision statement (Hampson & Brandon 2020) which, among other things, acknowledged the importance of moving towards off-site construction (OSC). This shift was acknowledged by research participants:

“By 2030 it is estimated that at least in Australia 50% of the components used in building construction will be manufactured off-site” (Building Industry Regulator).

Off-site construction emerges as an innovative technique with the potential to provide social and affordable housing (Oti-Sarpong et al. 2021; Thompson 2019) in response to the housing challenges faced by CHPs discussed in the previous chapter, as well as the rationale behind the need for an innovative method of construction for CHPs. This chapter will look briefly at the maturity of OSC techniques both globally and in Australia, as well as the opportunities and challenges that the Australian construction industry faces in adopting OSC as a mainstream

construction technique. This will be followed by a chapter that looks at some of the attempts made by CHPs to adopt OSC in the face of logistical and regulatory challenges.

4.2 International and national uptake of OSC

OSC methods are used in both developed and developing countries, where the need in the developed world is to provide quality affordable housing that meets societal needs. In the developing world, the emphasis is more about the mass production of low-cost housing (Goulding & Arif 2013). The international context referred to in this study represents developed countries who have similar housing interests to Australia (Steinhardt & Manley 2016).

4.2.1 *Off-site Construction in the International context*

One way of analysing OSC methods is to understand the regional differences between countries and economic diversity of OSC adapters and non-adapters. Many Scandinavian countries and parts of Europe have adopted OSC as a mainstream form of construction, with modules being transport between neighbouring countries by road (Halman, Voordijk & Reymen 2008; Oti-Sarpong et al. 2021; Steinhardt et al. 2020). These countries have engaged in mass customisation of building products to meet individual housing needs (Barlow et al. 2003). Weather emerges as an important driver of OSC in these countries, as construction can only take place for a limited period of time each year. Constrained by time, many of these countries recognised the importance of incorporating lean manufacturing techniques, which maximise productivity while minimising waste, into their construction workflow if they were to keep up with housing demand. (Halman, Voordijk & Reymen 2008). Japanese car manufacturers have also emerged as a model for housing construction (Barlow et al. 2003), where onsite construction projects were converted to off-site factory-based manufactured/building processes (Bertram et al. 2019). Many countries gained competitive advantage by using OSC methods to modularise housing design so that they could be cost effective and affordable on their product offerings to the residential housing sector (Steinhardt & Manley 2016).

Countries who wanted to solve their housing needs often endorsed off-site construction techniques using Government led building programs to encourage research and innovation in the sector (Barlow et al. 2003; Oti-Sarpong et al. 2021; Steinhardt & Manley 2016; Thompson 2019). More recently, as a response to recovery efforts from the COVID-19 pandemic, Governments of some OECD countries encouraged big construction rollouts that resulted in the

permanency and importance of OSC (OECD 2021). Further, many countries have used regulatory reform to support the application of OSC methods of construction to deliver diverse housing needs (Daniel 2016; Dawkins 2011; De Mendoza 2018; Halman, Voordijk & Reymen 2008). The opportunities and challenges of OSC adoption by many countries have been well documented, yet little is known about perceptions of OSC as a construction method in Australia (Blismas & Wakefield 2009).

In Australia, OSC is widely used in the construction of portable structures (Steinhardt et al. 2020). Despite varying legislation in each state, the technique of OSC modules has advanced far beyond the Australian caravan park model of portable manufactured homes in many parts of the world (Duc, Forsythe & Orr 2014; Oti-Sarpong et al. 2021; Steinhardt & Manley 2016). Section 68 of the Local Government Act 1993 governs portable structures in NSW. The Act specifies the controls that must be met before local councils can grant approval, as well as the circumstances under which approval for manufactured homes in NSW is not required. As a result of the Act, firms in NSW are looking to OSC as a solution for portable structures rather than a method to manufacture permanent homes:

“Australia has done well in the manufacture of portable structures for institutional use such as mining and schools. The structures are still not suitable for single line ownership” (Building Industry Regulator).

“Everything that is not built on site and is unable to be inspected and certified that cannot go through the normal approval process goes under Section 68. It must carry a compliance plate on the structure” (Council Participant 4).

With an affordability crisis for housing spanning the world the construction industry is experiencing accelerated change. The OSC market in North America has seen a 50% growth from 2015 to 2018 with the top 2500 construction companies globally increasing their R&D spending by 77% since 2013 on innovative construction methods (Ribeirinho et al. 2020; Sutrisna, Ramnauth & Zaman 2020). This brings up the question of whether Australia's construction industry as a whole has deprived the residential housing sector of any opportunities presented by global innovative trends in residential construction.

4.2.2 Regional differences in OSC adoption in Australia

In comparison to other continents, Australia's vast geographical size and relatively small population, which is concentrated in a small number of cities, has emerged as one reason for low uptake in OSC and a lack of skill and knowledge in this area (Hampson & Brandon 2004). Participants identified a lack of knowledge as a major barrier to OSC adoption, which may explain regional differences in OSC adoption in Australia:

“Due to the lack of knowledge in this area there is a common perception that it is an expensive process. The industry itself does not work towards change or want to change. There is this tendency to do nothing or to remain unchanged” (Tier 1 Developer 1).

The adaptation of OSC methods has been partially influenced by regional differences and economic diversity between the two major states of New South Wales and Victoria. In Victoria there is a level of public and State government acceptance for OSC methods, due to an established working partnerships between universities and the construction industry (Centre for Advanced Manufacturing of Prefabricated Housing 2020). For participants in this research, this longer history of OSC in Victoria meant that they were more able to undertake OSC projects, including more complex builds, such as apartments:

“It was also found that some of the manufacturers in VIC are capable for doing high rise apartments using OSC methods” (Tier 1 Developer 1).

“Most manufactured home suppliers are in Melbourne where the cost can be substantial for a Sydney person planning to use modular” (Council Participant 4).

“In Victoria there is some level of legitimacy in OSC, and that is by working closely with Universities” (Building Industry Regulator).

Some New South Wales construction industry experts are of the opinion that the strong manufactured housing industry in Victoria is a result of the effort to salvage the wrecks of advanced manufacturing that was present in the dismantled car industry (Green & Newman 2014). Victoria was seen as having a more advanced manufacturing culture that was more open

to accepting innovative developments, and developers saw it as a convenient place to try out modularised OSC developments. (Urban Development Institute of Australia 2020). The nature of the existing manufacturing facilities in Victoria and Queensland means that research participants have tested their OSC methods in these states:

“We test most of the prototypes and pilot projects in Victoria and Queensland so that the projects stack up putting less stress on their commercial assessment” (Tier 1 Developer 2).

In the Australian context, and despite the fact that Western Australia was an early adopter of OSC, with historical references in literature about its use during post-war periods (Taylor & Gregory 1992), participants highlighted that the regional acceptance of OSC in Victoria and Queensland differed significantly from that in New South Wales. The geographical landscape, regulatory constraints, land cost, and investment potential of land, rather than its use for residential purposes, may all play a role in determining the level of acceptance in NSW. Section 4.2.3 delves into the awareness and maturity of OSC adoption in NSW.

While some regions are more likely to adopt OSC techniques many large developers were resistant to change and preferred to use traditional construction methods. These developers show little interest in educating the public and industry regulators about innovative, sustainable, and cost-effective construction methods. A participating off-site manufacturer from NSW stated that large developers have overshadowed public awareness of OSC:

“The public are unaware of the potential and if they did, we would be overwhelmed and will need a factory 10 times as big to cater to such demand. That’s why the big builders don’t want us in the market as it ruins their business model” (Off-Site Manufacturer).

4.2.3 Awareness and industry maturity of OSC in NSW

In a study conducted in 2020, a total of 83 companies across Australia were identified as manufacturing and delivering OSC volumetric structures, which are built by connecting a series of fairly large pre-built sections called modules to end users, acting as both product suppliers and intermediaries. Many of these volumetric structures were for detached houses (Steinhardt et al. 2020) and with a majority of them popularly known as granny flats in NSW.

Adopting OSC manufacturing depends on cost, design options offered and the level of flexibility around the design. NSW developers, who were confident about the market opportunities for conventional building methods, felt that very few people in the Sydney residential development market looked at OSC methods for housing:

“Sydney has always been arrogant by considering themselves to be the benchmark with high prices in the market. There has not been enough thrust to consider solutions outside of the box. Melbourne have always been innovators” (Council Participant 1).

Because developers have already established themselves in conventional building processes, residential developers and builders in NSW who wish to transition from conventional to OSC methods face significant risk. There is concern that these organisations' adoption of an off-site construction approach will result in a radical shift in their operating business model, which is based on a subcontracting business structure aimed at remaining competitive and mitigating business risk:

“Construction industry is slow in taking up new technologies because builders are comfortable to use same subcontractors as high-risk projects can wipe out margins” (CHP Participant 3).

Fear of implementing OSC is due, in part, to a lack of knowledge and experience among developers and builders in managing an OSC workflow, as well as the absence of a strong regulatory framework in NSW supported by building codes and an OSC-specific chain of verification. Government initiatives to promote innovative construction methods are lacking (Blismas & Wakefield 2009). In 2015, NSW planning authorities issued a discussion paper on the Local Government Act, outlining the need for regulatory reform (NSW Department of Planning and Environment 2015). It was acknowledged that the Act was unsuitable for residential developments because it did not cover the use of modern construction processes:

“Compared to Victoria who has a conducive environment for modular, the NSW government does not provide actual motivation. This could be due

to a combination of arrogance from developers and state government who puts a spin on how things should be” (Council Participant 2).

Due to the lack of a proper regulatory framework and Clients' unfamiliarity with OSC procedures, developers have frequently been hesitant to offer OSC as an alternative for conventional onsite building methods (Sutrisna, Ramnauth & Zaman 2020). Developers and housing providers interested in pursuing OSC methods have been forced to look interstate due to a lack of interest in the NSW construction industry:

“At this stage we have come across one or two modular suppliers in NSW and the rest of them mainly coming from interstate. Most of them are positioned in rural VIC and QLD” (CHP Participant 5).

“Where I use to live most people opt for manufactured homes because there is a shortage of builders and the few who are in the region are ridiculously expensive” (Council Participant 4).

Unless an organisation or industry body with a public interest in making housing affordable takes the initiative, there appears to be very little appetite for these industry dominant large organisations in NSW to gain a competitive advantage through innovative methods because they are already established in the market and take the lead in construction and profit. A participant shared their experience had with such an organisation while looking at ways to be innovative:

“The experience with developers suggests that there are small innovative pockets pushing to do things differently in a larger building arm of the organisation that is hesitant.” (CHP Participant 1).

Despite the barriers to entry, some Sydney manufacturers have taken up OSC approaches to deliver housing in NSW. They are forced to position themselves in rural areas due to the market opportunity caused by the high construction cost and labour prices in these areas:

“Where I use to live most people opt for manufactured homes because there is a shortage of builders and the few who are in the region are ridiculously expensive” (Council Participant 4).

4.3 Opportunities from adopting OSC methods

Making the change from project-based conventional construction to a factory-based product manufacturing process (Bertram et al. 2019) can provide opportunities that project-based construction does not offer. While opportunities may benefit some, they may also expose others to new competition. Despite the numerous advantages OSC offers, this section focuses on the opportunities raised by participants.

4.3.1 *A shift from outdated construction work practices*

The construction industry is currently facing high-cost pressures and material shortages amidst a worsening housing affordability issue in Australia (Hampson & Brandon 2020). The digitalization of products and processes and the emergence of new technologies and materials has caused disruption in the global construction industry. It has provided an opportunity for new entrants engaged in innovative approaches to gain competitive advantage by offering cost efficient and timely development solutions (Ribeirinho et al. 2020). This trend is yet to emerge in Australia despite the issues surrounding affordability and housing supply.

The construction industry's project-based mindset towards subcontracting has frequently been to maximise profit by bearing the least amount of construction risk. The majority of new projects are planned by assessing the opportunities and risks of previous projects, compelling developers to adhere to an already established construction methodology (Hampson & Brandon 2020). With a stringent regulatory framework that provides little incentive to try new methods, developers frequently use the opportunities that OSC offers to stay competitive against users of outdated work practises.

The repetitive elements of OSC can be a preferred candidate for managing the chain of verification for work completed off-site due to the holistic interconnection of different processes. Because regulators have frequently questioned offshore and off-site work practises, many developers have been forced to avoid OSC methods due to the inability of regulation to keep up with modern work practises:

“The project will be approved at this stage only if the developers can demonstrate to the regulators that an authentic chain of verification exists and that the project will not cause residential harm.” (Building Industry Regulator).

Despite this, the shortage of skilled labour and the decline in new entrants into the construction workforce (Australian Government 2021; Ribeirinho et al. 2020) can be a powerful influencer and opportunity for developers to adopt OSC methods. Industry respondents research conducted in 2020 by The Cooperative Research Centre for Construction Innovation (Hampson & Brandon 2020) concluded that OSC would have a very high likelihood of occurrence in the next 5 to 15 years. An industry regulator expressed a similar viewpoint:

“By 2030 it is estimated that at least in Australia 50% of the components used in building construction will be manufactured off-site. The regulatory body will need digital maturity to keep abreast with these industry changes” (Building Industry Regulator).

4.3.2 Reducing the carbon footprint of construction

Apart from the extreme heat in various parts of Australia, negative construction consequences such as the change in climate conditions experienced by early OSC trend setters in Europe (Duc, Forsythe & Orr 2014; Steinhardt & Manley 2016) was not a compelling factor for OSC adoption in Australia. The global awareness on climate change has put increasing pressure on the building industry to cut carbon emissions, which presents the opportunity for the adoption of OSC (Moradibistouni, Vale & Isaacs 2019; Ribeirinho et al. 2020).

Because of the construction industry's impact on global warming, builders have been compelled to reduce construction waste and improve the sustainability of built environments. Building material innovations, design improvements, and the need for recycling of construction waste all contribute to the need for developers to have more control over their actions as builders and to be responsible for their carbon footprint in the future. The opportunities provided by OSC as a result of a lean manufacturing process carried out under controlled conditions have compelled responsible developers all over the world to embrace OSC methods in order to reduce their carbon footprint (Moradibistouni, Vale & Isaacs 2019). Many governments and regulatory bodies

have recognised the need to standardise building codes, issue compliance certificates, and provide approvals for factory manufactured construction processes in response to this shift.

Without a defined policy and planning pathway for OSC developments in NSW, it has frequently been difficult for developers and off-site manufacturers to deal with local councils that evaluated projects against regulations applicable to conventional building processes. One such example is Section 68 of the Local Government Act 1993, which allows OSC manufacturers to waive the requirement for a construction certificate or Building Sustainability Index (BASIX) compliance for manufactured homes:

“The issue is that under section 68 a manufactured home does not trigger BASIX building sustainability requirements making it an affordable home that is not sustainable” (Council Participant 4).

Concerns about the environment, as well as a growing willingness to embrace sustainable construction practises, have created an opportunity for standardisation, which is a key feature of OSC, and can allow certain elements of a primary development to be accepted under a Complying Development Certification (CDC) pathway. Secondary dwellings such as granny flats that are ancillary to a principal dwelling where the standardisation feature of OSC is most commonly used do not require CDC or BASIX compliance despite the opportunity OSC has to be compliant.

4.3.3 Meeting the demands of affordable housing

The unmet demand of affordable housing and the need to redevelop dilapidated social housing stock requires the state housing authorities to shift from historic onsite construction methods and promote more productive and cost-efficient construction approaches (Thompson 2019; Urban Development Institute of Australia 2020). The roll out of a state lead development initiative using innovative OSC methods could act as a catalyst for a home-grown industry where private developers are forced to follow suite if they are to remain competitive in the residential housing sector. If OSC methods are led by the state, some of the barriers to entry erected by a small group of large developers can be dismantled (Valence 2012). A recent state budget commitment by Western Australia (WA) has seen tenders being called to build OSC housing by WA housing authorities (Department of Communities WA 2021).

Historically, manufactured homes in caravan parks were a popular tourist accommodation in NSW. The diverse needs for affordable housing have compelled certain regions in NSW to transform these caravan parks into alternative housing delivery models (NSW Department of Planning 2020). OSC methods can provide local councils and operators the opportunity to transform these sites into permanent residential developments. Concerning unmet demand for affordable housing in NSW, Chapter 5 will investigate whether OSC provides opportunities for CHPs in their efforts to manage public housing and provide more affordable housing.

4.3.4 Adopting the best of both methods

On-site construction refers to the use of traditional building methods in which all work is completed sequentially on-site. Off-site construction typically refers to the modularisation or pre-fabrication of building components before bringing them to the job site for installation. As a strategy to remain competitive in a price inflation market (Arcadis International 2020), developers have adopted a combination of both these methods to the extent of indirectly relying on overseas suppliers for OSC building components:

“I am aware that some volume home builders in Australia are currently looking at off-site manufacturers in China and the Thailand for their building components” (Off-Site Manufacturer).

Taking advantage of the time savings provided by OSC methods, some developers made little mention of the OSC process itself, instead rebranding it as a niche product offering to their clients. With soaring land prices in Sydney, many large volume home builders used OSC to remain competitive in their offerings to time-constrained first home buyers. Given the certainty of a proper regulatory framework, large developers have the opportunity to offer cost-conscious CHPs a timely alternative to conventional construction by combining both methods:

“An existing builder/manufacturer offering factory build in combination with a conventional approach is the scale that we are looking for in social housing” (CHP Participant 2).

The opportunity to completely shift from a conventional project-based construction approach to a product-based manufacturing approach such as OSC has its own set of opportunities and

benefits, but it also has its own set of challenges and concerns (Blismas & Wakefield 2009; Sun et al. 2020; Urban Development Institute of Australia 2020), which will now be discussed.

4.4 Challenges in adopting OSC methods

Some of the difficulties encountered when using OSC methods may be the result of many years of industry experience being ingrained in the mindset of builders and developers who have built their skills and business opportunities around conventional methods. Aside from OSC acceptance, other challenges include regulatory, logistical, and capital constraints.

4.4.1 *Acceptance as a mainstream construction method*

Despite the many references about the use of OSC methods in reports published by reference committees and working groups that were appointed by the Commonwealth and State Governments, there is little evidence that these recommendations on OSC have been applied by local governments in efforts to address the affordable housing problem (Economics References Committee 2015; NSW Department of Planning 2020).

According to one participant, the acceptance of OSC methods by the construction industry would have been less challenging if the Commonwealth and State Governments had been more proactive. Both governments had the opportunity to learn from global examples (Bertram et al. 2019; Steinhardt & Manley 2016) and create housing prototypes to see if OSC methods could have been used to compensate for rising construction costs and if it could have been a solution to the housing crisis:

“At both Commonwealth and State there is no proactive approach to look at what OSC can offer. At both levels they just wait for it to happen” (CHP Participant 2).

The lack of Government initiatives to recognise and legitimise OSC as a mainstream construction method has seen some developers and volume home builders gain competitive advantage by combining OSC with conventional building methods:

“They are secretive about using OSC. We’ve seen that in NSW there are developers who have already delivered many projects using non-conventional methods for construction” (CHP Participant 5).

“Council is of the view that most of the installations and fittings for them will be done in a factory offsite that minimises their time and effort onsite” (Council Participant 1).

Some developers have termed it as a hybrid approach to construction, although it has not been recognised by regulation or in the Australian Building Codes:

“The project was more a hybrid version with a combination of conventional and off-site construction” (CHP Participant 4).

Although the NSW Apartment Design Guide recommends a modular construction approach for low rise medium density residential developments (NSW Department of Planning and Environment 2018) there has been no proactive approach to implement legislation that specifically regulates OSC methods in NSW. This is despite the predictions of future growth in OSC methods (Hampson & Brandon 2020; Ribeirinho et al. 2020) and claims made by regulators about the absence of a valid chain of verification for work done off-site:

“The regulators are capable of only certifying around 10% of the design when placed onsite where the balance of the stages is unknown to the regulator” (Building Industry Regulator).

“I suggest not to bring offsite anywhere near multi-unit residential developments in NSW. Most products supplied are not compliant and they lack an authentic chain of verification” (Building Industry Regulator).

The acceptance of OSC methods by third party organizations such as investors and funding organisations are reliant on the legitimacy placed by the state. The lack of a government or industry-led research and development (R&D) strategy that can be used for policy formulation has raised concerns among developers, builders, and regulators about the adoption of OSC methods:

“Policy is generally limited to telling an industry what it can do or demonstrating how it can be done. Regulation, on the other hand, only specifies what must be done in order to comply.” (Tier 1 Developer 1).

“If only the state can endorse manufactured homes as a mainstream construction method that the banks can lend for” (Off-Site Manufacturer).

“Council is not concerned about the construction method as far as it meets the required regulations” (Council Participant 1).

The NSW Government can initiate R&D by developing prototypes in collaboration with industry experts and developers. This will provide the opportunity for the state to initiate reform of building codes, safety standards and sustainability regulations. This will enable the state to evaluate design standards and benchmark OSC performance, define points of interaction to improve practices and strengthen the off-site verification process and identify appropriate skill requirements needed in a changing industry (Hampson & Brandon 2020):

“NSW moves a lot slower when compared to Queensland and Victoria in terms of regulation. The perception is that QLD and VIC are more willing to try out alternative approaches” (CHP Participant 1).

4.4.2 The regulatory framework

Local governments' approach to evaluating OSC developments and their components under legislation designed for traditional building methods may soon reach a tipping point where change is required. One participant expressed regret that the recently enacted Design and Building (DAB) Practitioners Act 2020 did not allow for innovative approaches:

“It will be very challenging for off-site as it has been hard enough to understand how legislation applies to the scope of traditional building. The DAB Act has no mention about other innovative approaches” (CHP Participant 4).

The construction industry in Australia is managed by a series of regulations ranging from building permits, material compliance certificates to work site safety controls (Hampson & Brandon 2020). As each state has its own methods of regulating building practices it has been challenging for developers operating in multiple states to comply with each state's requirements when standardising products, materials, and processes. This presents a challenge for businesses that intend to implement OSC methods in each state. Companies must manage a cross-state business strategy if they are to reach a size that makes OSC operations financially viable. According to one participant, the recently passed Residential Apartment Buildings (RAB) Act 2020 in New South Wales is more stringent than those in other states. The Commonwealth Government, with industry support, should encourage national uniformity of building codes practice and legislations across states:

“VIC regulations are more stringent than NSW but are more flexible. On a fire engineering point of view NSW has always been pretty tight. Now with the RAB enforced in it only gets harder in NSW” (Tier 1 Developer 2).

A key objective of local governments should be to enable CHPs to provide diverse housing needs (Milligan et al. 2004; Rowley & Phibbs 2012). State policies and local planning guidelines have often caused housing unaffordability by depriving communities from choosing where they work and where they want to live (Dawkins 2011; Dawkins & Koebel 2009). Local government planning mechanisms have often limited OSC methods to manufactured housing that are mostly associated to secondary dwellings and caravan parks rather than be seen as a solution for permanent affordable housing for metropolitan communities.

According to one participant, in the absence of a national strategy, each state administers their own regulations. Local governments in these states have their own policies and procedures, with some using a place-based planning approach and others pushing for sustainability requirements:

“In this context it is very difficult for a builder/developer to invest in a manufacturing facility that produces a standardised product that creates economies of scale which is aimed at making housing more affordable” (Tier 1 Developer 2).

As previously stated, while a small number of council participants were unconcerned about the construction method, many council participants believed that NSW needed a proper regulatory framework that endorsed off-site constructed homes as a mainstream construction method rather than as a movable structure regulated under section 68 as a manufactured home. Some of the key legislation that 'supports' OSC methods termed as manufactured housing in NSW legislation includes the *Local Government Act 1993*, *Local Government (Manufactured Home Estates, Caravan Parks, Camping Grounds and Moveable Dwellings) Regulation 2005*, *State Environmental Planning Policy (Affordable Rental Housing) 2009*, and *State Environmental Planning Policy (Exempt and Complying Development) 2008*.

Despite these pieces of legislation, it has often been challenging for OSC adopters, manufacturers and third-party certifiers to satisfy the planning needs of local governments who prefer to ignore the method of construction and apply development control plans designed for conventional building approaches:

"The construction method is more of a concern for an authorised certifier, who must ensure that the building meets proper building control standards before issuing the construction certificate." (Council Participant 2).

4.4.3 *NSW Land prices holds back opportunity for innovation*

The high cost of land in NSW, combined with stringent building regulations, has compelled developers to look for alternative states that provide a conducive environment for innovative building approaches such as OSC. Developers have attempted to roll out a few projects in Victoria and Queensland using OSC cross laminated timber (CLT) components and volumetric units, despite having few opportunities to publicly demonstrate the potential of OSC techniques in NSW:

"The simple answer is the cost of land. We test most of our prototypes and pilot projects in Victoria and Queensland so that the projects stack up putting less stress on their commercial assessment" (Tier 1 Developer 2).

With only a few large building companies capable of testing OSC methods, it has been difficult for project owners to compel developers to display OSC prototypes or completed projects in NSW:

“The difference between New South Wales and Victoria is that the land prices are too high for experimentation. There is not much appetite to take the risk of an innovative approach on an expensive block of land”
(Tier 1 Developer 1).

4.4.4 Capital investment a barrier to entry

As a continent isolated from other countries, Australia’s market potential for OSC products has been limited due to the geographical distance from global construction markets. By not having a large enough market, many developers are unable to justify their investment in a complex manufacturing process such as OSC:

“Large scale builders and developers will need some convincing from the market to invest in a capital-intensive modular manufacturing operation”
(CHP Participant 5).

“Manufacturers who want to play in this space and want to become a significant proportion of the market must be properly capitalised”
(Building Industry Regulator).

“Despite modular projects having had their success globally, I believe we need to go back to Australia and focus on the fact that we live in Australia and must have trustworthy buildings that are backed by supply chains who are serious about compliance and business continuity” (Building Industry Regulator).

If developers are to achieve the commercial scale required for OSC to be a viable alternative to conventional building methods, significant capital expenditure is required. Despite the legislative limits, developers in Australia have frequently been compelled to go to international manufacturers to supply off-site produced components and pods for their developments in order

to reap the benefits of OSC processes. A few developers with the financial means to invest in a manufacturing plant pitched OSC as a factory-built system, but were unable to show a prototype to potential customers, according to one participant:

“We looked at two potential factory-built systems in Australia where both manufacturers claimed huge benefits but were unable to show a OSC prototype” (CHP Participant 2).

The ambitious move to manufacture components and pods off-site in Australia was short lived by a fledgling company in NSW being forced into liquidation (Michael 2018; Perinotto 2019). This was followed with the global attention on the abrupt bankruptcy of Katterra, a leading technology-driven off-site construction company in America (Tabet 2021). These events had an effect on OSC acceptance and slowed the momentum that OSC methods had gained in the Australian construction industry. The government, like many other countries that had used OSC methods to increase the supply of affordable housing (Steinhardt & Manley 2016; Thompson 2019), had the opportunity to secure this fledgling industry by granting subsidies and managing import tariffs. Although it was felt that the goal was to reduce competition, the industry body's leadership role in representing off-site manufacturing as a mainstream construction approach in Australia was insufficient:

“Ad hoc adventures from companies who did not understand how to create a mainstream construction method but used the method just to take down competition failed. The role of the industry body should be to set industry standards if they were keen to see OSC as a mainstream construction method in Australia” (Building Industry Regulator).

4.4.5 Transportation and logistics

One significant advantage of OSC is that it reduces construction time by using volumetric units (Sutrisna, Ramnauth & Zaman 2020). Despite the advantages of volumetric unit placement, developer participants who built multi-residential townhouses and apartment complexes were hesitant to use volumetric structures and instead recommended the use of cross laminated timber (CLT) components and pods. This was done to compensate for transportation hassles and costs, as well as access restrictions to properties that were being developed:

“As developers we have done a lot of research in this space and found that the transportation of 3D Volumetric modules is expensive due to the transportation of void space” (Tier 1 Developer 2).

The shape and size of the land have been a constraint for project owners who have attempted to use OSC methods. Because of the nature of the project and the costs associated with transporting and installing modules on-site, developers have had to forego the efficiencies and cost savings offered by OSC through standardisation. When alterations and variations were required during the building process, the element of standardisation and repetitiveness in OSC methods was seen as a barrier:

“The challenge is to prepare a design within council controls that can be site specific and above and beyond SEPP 68 requirements. The shape of the land, setbacks, modulation of the building does not allow for a standard structured approach such as OSC” (CHP Participant 7).

4.5 Conclusion

If OSC is to be accepted as a mainstream construction method in NSW, some believe that projecting it as an affordable housing solution may stigmatise OSC as a low-cost alternative for conventional building methods. Despite these challenges and opportunities, regulators believed that the potential of OSC was little known in Australia due to a weak industry body representing OSC methods. (De Mendoza 2018; Steinhardt & Manley 2016). Despite the fact that Australia had a history of using OSC methods, post-war stigma (Taylor & Gregory 1992) limited this method of construction to just caravan parks and portable structures.

Adoption of OSC methods for residential purposes in Australia may have been impacted due to the regional differences in regulatory acceptance and the absence of supportive infrastructure in each state. According to a participant comment, Victoria and Queensland were far ahead of New South Wales, who has been denied the opportunity to try out OSC methods due to stringent construction regulations that discouraged innovation which was exacerbated by high land prices. If OSC is to be accepted as a mainstream construction method in New South Wales projecting, it as an affordable housing solution may stigmatise OSC as a low-cost alternative for conventional

building methods. Despite these challenges and opportunities, regulators believed that the potential of OSC was little known in Australia due to a weak industry body representing OSC methods.

So far, we've looked at the housing development challenges that CHPs face, followed by a Chapter that outlines the pros and cons that an industry must weigh when deciding on Off-site construction (OSC) for residential developments. The following chapter will investigate participant perspectives in order to determine whether OSC can be used as a development strategy for CHPs to offer housing, as well as the attempts made, and challenges encountered by CHPs in doing so. Despite all the difficulties and the lack of a clear regulation, developers have frequently mixed the advantages of OSC with conventional methods and have deemed to satisfy building standards:

“Based on efficiency and cost, but also attractiveness and appropriateness and quality modular can deem to satisfy conventional construction standards” (Tier 1 Developer 1).

5 Can CHPs benefit from OSC methods?

5.1 Introduction

Despite the demand for social housing, there has been a lack of investment during the last two decades, and the number of social and affordable housing units has stayed relatively constant (Compass Housing Services 2021; Pawson, Milligan & Yates 2020). At the same time, housing in the private market has becoming more unaffordable, further increasing the demand for social housing (Fotheringham 2021; PowerHousing Australia 2021). The Community Housing Industry Association (CHIA) predicts that NSW needs to build, on average, an additional 5,000 social housing units per year, at a cost of \$2.2 billion per year (Equity Economics 2021). This amount will need to be spent annually over the next 30 years if NSW is to meet and maintain the Organization for Economic Cooperation and Development (OECD) average for social housing as a percentage of total housing stock (OECD 2019). In 1991 the social housing stock was at high at 7.1 per cent of total housing in Australia, and by 2018 this had fallen to 4.2 per cent, which is 2.9 per cent below the OECD average (Equity Economics 2021).

Providing the 5,000 additional social housing units per year in NSW is a significant challenge for CHPs. Despite the development capabilities of established CHPs in NSW, on average, they would each need to build and deliver over 50 units annually, comprising of 30 2-bedroom and 20 1-bedroom units (Equity Economics 2021). Addressing this shortfall will necessitate a significant investment. With a shortfall in required funding coming from the government, CHPs are increasingly expected to self-fund and deliver these dwellings.

With the constant advancements and technical developments in the manufacturing industry, an OSC workflow has often shown to be a more efficient and cost-effective construction approach than conventional methods. If some of the hurdles, such as regulatory change and industry scepticism, are resolved, OSC could be an appealing option for enabling new housing development by overcoming some of the funding constraints that CHPs face.

The chapter will investigate what motivates CHPs to consider OSC, whether attempts have been made to implement OSC projects, what challenges and barriers have been encountered, and

whether CHPs can use an innovative construction approach, such as OSC, in collaboration with their stakeholders.

5.2 What compels CHPs to consider OSC

The government's funding arrangements for CHPs, as well as the eligibility criteria employed by the government to meet the need for social and affordable housing, have an impact on CHPs' objectives when providing housing to the disadvantaged (Equity Economics 2021; Troy, van den Nouwelant & Randolph 2019). CHPs are forced to look into cost effective development opportunities that will increase their scale of operation in order to obtain government land, funding, and subsidies against those developed housing assets in order to sustain a not-for-profit business model within constrained funding and restrictive policy practises (McKinsey 2014; Milligan et al. 2009; Thompson 2019):

“Everything around scale is determined by the availability of having access to land, funding, and subsidies” (CHP Participant 4).

The need for alternate construction techniques is frequently felt by CHPs with constrained portfolios who are unable to secure resources from the government or through bank financing or who want to increase prospects by lowering construction costs.

Given the financial subsidies, it may be possible for an innovative building method, such as OSC, to be recognised as a mainstream construction technique, if some of the regulatory challenges discussed previously were addressed, making it an appealing alternative for CHPs (Gad et al. 2021):

“If there were subsidies to support more construction, it would have driven innovation in construction to look at areas such as OSC” (CHP Participant 3).

CHPs attempt to generate revenue by following two paths that are outlined for social housing management and the delivery of affordable housing. The funding for social housing comes in the form of an operating subsidy or a capital grant paid in advance to CHPs. The affordable housing provision is funded through a rental income stream, with CHPs receiving tax-exempt liabilities as

a subsidy on their rental incomes (Troy, van den Nouwelant & Randolph 2019). Despite the various revenue streams designed to assist CHPs, there is concern that these revenue streams will eventually dry up, limiting future development opportunities for CHPs. This is where the cost of land and construction for a development project may differ significantly in comparison to potential future income streams from such development:

“The housing funding pipeline will dry up subsequently creating a lack of capital subsidies that fund developments” (Housing Policy Advocate).

Some are concerned that potential future revenue streams from unmet and future social housing needs will not be sufficient to bridge the gap between the cost of providing tenancy and the cost of operations. If CHPs are forced to self-fund new developments, they may need to consider more cost-effective construction methods to match viable income streams from affordable housing developments in attempt to close the investment-to-revenue gap. In this context, an innovative construction method that reduces the initial investment cost can be viewed as a significant benefit for CHPs.

5.2.1 Combating increasing land prices and rising construction cost

The cost relating to the acquisition of land has often been a challenge for CHP development projects (Pawson, Milligan & Yates 2020). This is compounded by rising building costs and labour shortages in Sydney's construction industry (Arcadis International 2020; Australian Industry & Skills Committee 2021; Hampson & Brandon 2020). Despite these obstacles, the government's decision to use CHPs to address the worsening housing shortage (see section 3.3.1) has forced CHPs to seek out new ways to make developments viable. One response is for CHPs to attempt to collaborate with local councils to solve housing problems:

“There is definitely an affordable housing issue in Sydney. There have been number of projects that have been approved by the council with lot of land released” (Council Participant 4).

In order to address some of the housing challenges in areas where land prices are high due to market demand, many councils have released government-owned land to CHPs at concessionary rates as part of their affordable housing strategy and local planning process (see section 3.4.1).

This has not only allowed CHPs to expand their housing asset portfolio, but it has also compelled housing providers to evaluate new construction approaches in order to maximise yield on land opportunities received:

“When a council does re-zoning, they secure land in exchange for a higher yield which is then kept for community housing projects. CHPs are free to use any preferred method of construction based on its merits” (Council Participant 1).

When comparing the cost of construction using conventional methods, there is always a public misconception that if developers are to provide affordable housing solutions, the cost of construction must be cheaper to be affordable (Thompson 2019). Although construction costs can be a barrier to building low-income housing, the cost of constructing for a CHP should be weighed against the quality of the housing asset, lifetime maintenance, and long-term viability, rather than construction cost in order to make the development affordable.

When compared to conventional building methods, an OSC approach that uses a lean manufacturing process under controlled conditions to develop volumetric structures and components could help CHPs to be more cost efficient in their developments while maintaining quality (Barlow et al. 2003; McKinsey 2014; Navaratnam et al. 2019; Urban Development Institute of Australia 2020), making developments more affordable and efficient:

“Construction must be affordable for CHP’s housing to be affordable. This is a misnomer. Compared with a private developer, CHP’s look at long term upkeep and maintenance cost and the affordable needs of the end user. This results in the higher cost of construction per m²” (CHP Participant 4).

Developers using conventional onsite methods have often been challenged with labour shortages (Watson 2012) amidst the demands from cost-conscious end users, such as CHPs being eager to complete projects. Because of tight funding arrangements and stringent delivery timelines, CHPs necessarily look for building efficiencies. Case study evidence on OSC attempts made by CHPs suggests that the inability of a builder/developer to manage a project to the specifications of a CHP has compelled some CHPs to manage their own developments by

establishing an in-house team that holistically evaluates and subcontracts various parts of a project to certified builders and tradespeople. CHPs that manage their own developments often prefer to use an OSC approach to subcontract components of their developments to manufacturers who are less reliant on a costly skilled labour force.

The repetitive feature and factory conditions under which OSC methods operate allows for the retention of a consistent workforce capable of managing set quality standards, economies of scale, and less waste. The benefit of a quick turnaround makes OSC a viable alternative to time-consuming conventional building methods, that is reliant on a variety of tradespeople. A participant representing the development team of a CHP had this to say:

“With so many tradespeople working on a single bathroom on-site, the risk of compromising product quality increases. The quality advantage offered by an off-site process encouraged us to look at this option” (CHP Participant 4).

When considering OSC there can be savings in the initial upfront cost of a development. CHPs could benefit from the commencement of a project in a factory while the preparation of land takes place on site saving on both time and cost.

“The opportunities that OSC claims can offer, can be more advantages to a CHP’s business model in terms of time savings and cost. Time comes back to cost in the form of holding cost and interest payments. Savings in maintenance are absolutely essential for a CHP to function” (CHP Participant 5).

5.2.2 Lowering recurring maintenance costs

The development objectives of CHPs are not driven by capital gains derived from the sale of a developed property, but on the recurring savings they make from the asset over time. One such savings is from low maintenance. Reducing building maintenance has often been a priority for CHPs (Sharam et al. 2021). The project outcomes expected of a builder working for a CHP can differ greatly from those expected of a builder working for a developer building market housing. Unable to persuade developers, many CHPs manage their own developments by subcontracting

components to builders who have attempted to design-out maintenance and extend the useful life of CHP-developed housing assets:

“CHP’s priority is to design out maintenance cost and increase the useful life of the asset” (Housing Policy Advocate).

While the goal was to design-out maintenance, when asked if off-site construction methods would fall short of this goal, several participants believed that the cost of ongoing maintenance for OSC methods would be no different than for conventional construction methods:

“We assume that the cost of maintenance will be exactly the same if OSC is built within the material standards of a conventional build” (CHP Participant 2).

Unlike public housing maintenance liabilities, which are transferred to CHPs through stock and management transfers, CHPs are subject to a regulatory system that requires them to meet a wide range of performance outcomes on assets they own. The National Community Housing Standards Manual (Department of Families Housing Community Services & Indigenous Affairs 2010) stipulates the standards that need to be maintained by the community housing sector throughout Australia.

CHPs face more complex asset decisions as they grow and their stock ages, such as when to upgrade, replace, and dispose of dwellings (Sharam et al. 2021). In meeting these demands the prefabricated nature of OSC can aid CHPs to provide timely cost-efficient outcomes with minimum disruption to tenants.

Builders must maintain a level of consistency by standardising their product offerings to meet the repetitive layering design objectives of CHPs. Layering is when bathrooms are built above bathrooms on the floor below, and the same is true for kitchens. This significantly reduces costs. Many CHPs believe that OSC should provide cost efficiencies on their developments due to its repetitive characteristics. CHP development objectives are frequently constrained by limited development budgets (Equity Economics 2021). The repetitive nature of OSC in a factory environment necessitates continuous improvement in order to gain efficiencies through

economies of scale (Sutrisna, Ramnauth & Zaman 2020). This could assist CHP-managed developments in meeting tight budgetary targets:

“If CHPs are to consider OSC on new projects, the response will be very dependent on the cost, long term durability and the cost of maintenance over time” (CHP Participant 2).

The standard offerings of CHPs and the standardised feature of OSC may result in the holding of components that are commonly used in maintenance or module replacement, lowering maintenance costs and timeframes. With funding for new developments limited and construction costs rising, CHPs can rely on OSC to provide community housing at lower construction costs while ensuring long-term challenges associated with maintenance costs are within their control.

5.2.3 Enabling environmental sustainability

CHPs have found it difficult to find like-minded builders who align with their development goals to deliver OSC products especially when wanting to pursue the opportunities that OSC offers. Builders and developers believe that the current industry environment and market do not ensure business continuity if they adopt an OSC approach, let alone that it is affordable and environmentally sustainable:

“In current context it is very difficult for a builder/developer to invest in a manufacturing facility that produces a standardised product that creates economies of scale which is aimed at making housing more affordable” (Tier 1 Developer 2).

Despite its hesitancy to invest in OSC, the construction industry is finding ways to reduce their carbon footprint and become more sustainable (Adamson 2022; Ribeirinho et al. 2020). There is evidence to suggest that urban heat islands will increasingly impact the liveability and resilience of many cities in Australia (Infrastructure Australia 2019). As a result, many CHPs have made it a part of their development goal to consider sustainable building approaches that are environmentally friendlier, adaptable, energy efficient and cost less for the end users (Pawson, Milligan & Martin 2019):

“CHP’s want to reduce the burden on tenants by making developments more energy efficient” (Housing Policy Advocate).

“Councils “Cooling the City” project is looking at innovative approaches, and a perfectly energy efficient OSC home can be taken into consideration” (Council Participant 3).

A lean manufacturing process, such as OSC, managed under controlled conditions, can meet the demands for energy efficiency and environmental sustainability (Ribeirinho et al. 2020; Sutrisna, Ramnauth & Zaman 2020). New developments that address these needs may provide an opportunity for CHPs to persuade builders to move in this direction.

5.3 OSC attempts made by CHPs

CHP participants stated that when deciding which method of construction to use, they frequently considered the benefits that OSC methods could offer their multi-story residential development projects. The section presents three case studies of CHPs' attempts at such initiatives, all of which were met with varying degrees of success. Regardless of whether OSC is labelled as manufactured or movable homes, some level of OSC has been used in permanent developments throughout New South Wales.

Secondary dwellings, also known as granny flats, frequently use OSC methods and are encouraged by local governments in New South Wales by being assessed as compliant developments. This is part of an effort to provide more affordable housing (Daley & Coates 2018; Pawson, Milligan & Yates 2020). Despite the few CHP attempts there is also mounting evidence that OSC methods have been used in Australia for low-rise detached housing (Urban Development Institute of Australia 2020).

CHPs have frequently attempted to use volumetric units, pods, and cross laminated timber (CLT) components in order to reduce costs on their developments by using OSC methods. However, they have frequently been disappointed by the industry's inability to demonstrate any applications or prototypes based on OSC methods:

“We looked at two potential factory-built systems in Australia where both manufacturers claimed huge benefits but were unable to show a prototype” (CHP Participant 2).

There is little evidence that the construction industry has used modularised volumetric units to construct high-density residential buildings (Sutrisna, Ramnauth & Zaman 2020), which is an opportunity that CHPs are looking forward to:

“The big changes for OSC will be when it becomes a solution for multi-unit and higher density type developments. Currently OSC has struggled beyond 4-5 levels of construction in Australia” (CHP Participant 5).

Despite the opportunities that OSC could provide CHPs, the industry's infancy, and OSC being somewhat untested for multi-story community housing developments in Australia, CHPs have made attempts with varying degrees of success, revealing both the opportunities and challenges associated with OSC. Three of these attempts are discussed further below as case studies (5.3.1, 5.3.2, and 5.3.3).

5.3.1 Case Study 1: A completed project

The case study is based on a completed project in which a CHP collaborated with a local developer to import volumetric modules from China. In a housing market that had a few affordable rental spaces and a long waiting list of eligible clients, this case study was an attempt by a CHP's in-house development team to demonstrate that by using OSC methods, quality housing can be more affordable and delivered faster than conventional construction approaches.

Despite the stringent regulatory barriers that the construction industry faced in New South Wales (see section 4.4.2), the CHP development team embarked on a brave industry first move to create a medium density community housing project that included a four-story building with 23 studio apartments using OSC volumetric units:

“With the funding pipeline drying up the concept of modular could be a good option. The housing village by [CHP Participant 3] was a first step by CHP's” (Housing Policy Advocate).

Despite having previously had a strong development relationship with developers and builders on conventionally built projects, the CHP development team was forced to consider the recommendations of a local developer who suggested to use an overseas manufacturer because they couldn't find a suitable development partner or builder willing to take the risk of trying something new and innovative in Australia. The development team's inability to find an experienced builder who was familiar with OSC methods indicates a lack of maturity in the industry when it comes to implementing OSC techniques in Australia (Blismas & Wakefield 2009; Gad et al. 2021; Us 2019).

Despite a strong desire to test this new innovative method of construction, the CHP development team was forced to accept an offer from a conventional builder who planned to build a significant portion of the project off-site and offshore in China. The project was subcontracted to a Chinese company who was capable of displaying a prototype offshore. The stackable modules had to accommodate lifts, stairs, and hallways, and the local builder, in collaboration with the overseas manufacturer, claimed that the project would be 10% less expensive than a conventional construction approach:

“The project saved time but did not save money. For a private developer who is profit motivated time can be money” (CHP Participant 4).

This was not the case when the actual product was delivered. To comply with NSW construction standards, the builder was required to perform rotational inspection and certification on the manufacturing facility by flying out different certifiers who specialised in different trades. Aside from the cost of travel abroad, the CHP needed to ensure that the volumetric modules being manufactured for community housing met ethical standards and did not harm employees or the communities living near the factory:

“CHP Developers flew with the builder for inspection prior to signing the contract. We needed to ensure that the manufacture process was ethical and not detriment to staff and communities living around the factory” (CHP Participant 3).

Due to transportation and logistical constraints, the modules were highly standardised, forcing the design to resemble shipping containers. The builder had to spend more money and time to comply with local planning requirements for streetscape character, building façade, and setbacks. If the modules had been manufactured in Australia, the design's functionality could have been improved, and the time and money associated with these modifications could have been avoided:

“They had to modify their modules to meet planning requirements.

This made them forego their efficiencies derived from OSC” (Tier 1 Developer 1).

The CHP’s OSC initiative became an opportunity to demonstrate the capabilities, limitations, and potentials of OSC to the residential construction industry. Some industry experts believe it was a missed opportunity for the State Government as they could have used the learnings from the project to launch a study that better understood the potentials of OSC. The study could have initiated regulatory reform to make OSC become a mainstream construction method eliminating any misconceptions about it and expanded the supply of affordable housing:

“The NSW Government should initiate a pilot project to eliminate the misconception and stigma about it” (Tier 1 Developer 1).

“The industry would like to see many more real-life examples to understand what OSC can offer” (Housing Policy Advocate).

“The concern is that the industry will use social housing for their guinea pig work” (Building Industry Regulator).

Despite these comments, the project illustrated the benefits and drawbacks of employing OSC to develop a low-cost residential project. The case study discusses the obstacles of sourcing volumetric modules from overseas as well as the advantages the developer would have by sourcing them locally. Most significantly, it indicates that NSW's regulatory framework for the building industry has not kept pace with current construction methods and processes. Using regulation that’s suitable to certify conventional building methods to examine OSC processes

stifles the benefits that OSC can provide, making OSC adoption more difficult for builders and developers.

5.3.2 Case Study 2: A failed attempt to use an OSC approach

The second case study provides an example of an OSC initiative negotiated by CHPs with developers that did not materialise into built form due to builder reluctance and potential financial consequences:

“As an experienced developer/builder they didn’t sound confident in using OSC. You then ask yourself why an inhouse developer for a CHP should take the risk to do it” (CHP Participant 1).

As an industry leader in the community housing sector, the CHP had already established a reputation as a self-sustaining housing provider. There was an attempt to investigate OSC with a globally accredited developer based in Australia. The developer, who had been involved in many other conventionally built projects, had a strong developer-client relationship with the provider and was aware of the CHP's development needs. Knowing the advantages of OSC, the provider compelled the developer to offer an OSC-based solution for the large-scale development they were working on:

“The benefits from the use of OSC were being considered with the aim to gain program efficiencies in the project” (CHP Participant 1).

The CHP development team was aware of the opportunities and scale that OSC could provide for their growth. Recognizing the importance of having programme efficiencies as part of its development strategy on a time-sensitive project, they wanted the developer to approach construction differently by recommending an alternate construction process that could deliver an 18-story residential project in 18 months.

Despite the fact that the CHP had a small development team who wanted to try a different approach by using OSC, a well acclaimed reputable developer organization who had a larger building arm was unwilling to change from their normal development practices. The CHP team was surprised that a globally established organisation with extensive knowledge of OSC methods was unwilling to consider off-site as a product pitch in their portfolio of services offered to

Australia. The CHP development team had observed that there was still a small team of innovative thinkers within the organisation who were willing to try an OSC approach but were made unheard as their ambitions did not fall within the scope of the organisation:

“One would hope as an organization we look to experienced builders who do these all day every day to advise us. As an experienced builder they didn’t sound confident in using OSC...it was found that OSC was a difficult conversation within their own business” (CHP Participant 1).

The CHP development team and the developer to whom the project was outsourced were unwilling to engage in the same construction space for reasons discussed below. The developer was concerned that the project's scale and cost of delivering off-site manufactured volumetric units to site would be unfeasible. This could be attributed to the developer's lack of manufacturing scale, which was required for OSC to break even and be a viable alternative to traditional onsite building methods (Bertram et al. 2019; Duc, Forsythe & Orr 2014; Sun et al. 2020). The developer, who was also a participant in this study, believed that the transportation and placement of volumetric units on-site could have unanticipated financial and logistical consequences.

“Unfortunately, the time saving of two months did not justify the additional cost for the project when compared with the conventional approach. OSC needs to operate at a scale to be able to bring in the level of efficiency that is needed to match a conventional project budget” (Tier 1 Developer 2).

Because of the CHP's persistence and the time constraints encountered on this project, the developer advocated for the use of Cross Laminated Timber (CLT) panels rather than volumetric modules where the void spaces were not cost effective to transport. Despite this, the developers were hesitant to supply CLT because the panels would need to be over-engineered in order to meet the requirements of the NSW Residential Apartment Buildings Act 2020, which requires high fire proofing standards. Many of the negotiations and discussions the CHP had with the developer was lacking a firm commitment, as the developer's existing subcontracting business model would still have been incompatible with an OSC approach:

“People have the view that off-site construction is the solution and will change the industry. Off-site does not work in every scenario and can be very different when it comes to building houses. However, off-site when used correctly for the correct solution can provide absolute benefit” (Tier 1 Developer 2).

The case study emphasises developers' reluctance to adopt OSC methods. This is due to the resistance to dismantling the subcontracting business model, as well as the significant capital outlay required to set up an off-site manufacturing facility. Developers are unwilling to relinquish their market leadership in using conventional methods, and they also do not intend to lobby for reform that will allow OSC to be recognised as a mainstream construction approach.

5.3.3 Case Study 3: Misalignment of construction method and development objective

This is a case study of an attempt by the in-house development team of a CHP serving the aged care sector who planned to capitalise by incorporating OSC's repetitive manufacturing feature. The participant refers to it as a "cookie cutter approach," in which OSC volumetric units similar in size and shape are manufactured offsite and placed onsite against each other.

To better understand the concept, the builder who would be involved in this project had created a prototype of a volumetric unit for the CHP. The housing provider's development team was eventually forced to abandon the project because the revised residential care plan for the facility included common areas that did not necessitate a repetitive building approach, which OSC was good at. The literature frequently claimed the benefits of the lean manufacturing process and how it benefited the automobile industry. This case study disproves the notion that the same principles will apply in housing construction:

“Always an analogy that is made is, well, if we can do it for cars, why can't we do it for houses? There are some challenges around houses that are fixed and different to cars” (Tier 1 Developer 2).

5.4 OSC Opportunities & Responsibilities

The learnings from the three case studies have identified some of the main areas that can be of opportunity to some stakeholders when adopting OSC methods while for others it can be more a responsibility to facilitate industry change towards enabling OSC to be recognised as a mainstream construction method in NSW. Unsurprisingly, it was observed that participants within each group were more homogeneous in their views while heterogeneity was observed across the views of each stakeholder group.

In doing so Table 5.1 below displays a list of opportunities that *Supply Side* stakeholders such as CHPs, off-site manufacturers, residential developers and conventional builders can gain by adopting an OSC approach in their developments and in doing so the responsibilities they should take to facilitate change.

Table 5.2 displays a list of responsibilities that the *Governing Side* stakeholders such as building regulators, all levels of Government, and Industry bodies can take to initiate industry wide change if OSC techniques are to benefit community housing provides and the housing sector at large in NSW.

5.4.1 Supply Side Stakeholders - Social & Affordable Housing Sector

Based on the perspectives offered by stakeholders who have been challenged to supply housing Table 5.1 highlights the opportunities for and responsibilities of each stakeholder if they are to realise the benefits that OSC delivers.

	<i>Community Housing Providers</i>	<i>Off-site Manufacturers</i>	<i>Residential Developers</i>	<i>Conventional Builders</i>
Cost of Residential Construction	Opportunity Bridging the gap between investment and return on new developments.	Responsibility Develop confidence by demonstrating the cost advantages of OSC to end users.	Opportunity Convince market segments that have been using conventional building methods.	Responsibility To be transparent of the use of OSC components that reduce the cost of construction.
Development Efficiency	Opportunity Completing a project early provides an early income stream that looks financially better.	Opportunity OSC ensures competitive advantage above conventional methods	Opportunity Create product differentiation by using OSC's short development timelines.	Opportunity Justifies process change from onsite to off-site building methods.
Project Funding	Opportunity Predictability and consistency between OSC projects can provide investor confidence.	Responsibility Initiate negotiation of settlement terms based on OSC process uniqueness rather than by project.	Responsibility To be transparent about the uniqueness of OSC and work alongside lender institutions.	Opportunity To explore various types of funding that will permit off-site construction over onsite methods.
Regulatory Reform	Responsibility Initiate regulatory reform through sector representation	Responsibility Lobby for regulatory reform by taking the position of being an industry leader who follows best practices.	Responsibility Take up issues between the local and state review and inspection processes for OSC methods.	Responsibility Support regulatory reform initiatives aimed at validating OSC processes as a mainstream method of construction
Environment Sustainability	Opportunity Provides energy savings for low to medium income clients.	Opportunity Differentiate OSC product offerings from conventional methods.	Opportunity To develop low carbon energy efficient residential buildings.	Responsibility To lower the carbon footprint by moving out of conventional residential building.
Capital Investment	Opportunity Attract private capital investment to provide social & affordable Housing stock.	Responsibility Lobby for regulatory reform by taking the position of being an industry leader who follows best practices.	Opportunity Develop private capital partnerships with offshore investors already established in using OSC.	Opportunity Develop investment partnerships with established OSC companies to offer hybrid development solutions.

Table 5.1: Supply Side Stakeholder Opportunities and Responsibilities

5.4.2 Governing Stakeholders – Residential Construction Industry

Table 5.2 outlines the opportunities for and responsibilities of governing stakeholders in the housing and construction industries in order to reap the benefits of OSC.

	<i>Building Regulators</i>	<i>Local Government</i>	<i>State Government</i>	<i>Commonwealth Government</i>	<i>Industry Bodies & Advocates</i>
Cost of Residential Construction	Responsibility Review and reform cost associated with the certifying process.	Responsibility Initiate local planning reforms that take advantage of the cost benefits of OSC.	Opportunity Expand affordable housing delivery.	Opportunity Redevelop social housing and combat national homelessness.	Responsibility Publicly demonstrate the benefits of OSC and lobby for reform.
Development Efficiency	Responsibility Streamline the certification process to take advantage of efficiencies derived from an OSC process.	Responsibility Provide fledgling OSC organizations the support needed to establish.	Responsibility Initiate state planning reforms that align with modern construction efficiencies.	Responsibility Initiate legislative change to recognise industry best practices and innovation.	Responsibility Initiate industry led research to demonstrate productivity & efficiencies in using OSC.
Project Funding	Responsibility Initiate regulatory reform for institutional acceptance.	Responsibility Initiate reform to align approvals & certifications to reflect the novelty of OSC methods.	Responsibility Initiate reform for acceptance by housing funds and institutional lenders.	Responsibility Initiate legislative change to promote institutional acceptance	Responsibility Lobby for reform to enable flexible financing for supply side stakeholders
Regulatory Reform	Responsibility Acceptance of OSC as a mainstream construction method.	Responsibility Initiate reform to reduce time & uncertainty in reviewing entitlements, permissions, & inspection.	Responsibility Initiate reform to reduce time & accept parts of OSC processes as complying developments.	Responsibility Improve the consistency and clarity of state and local reviews of OSC projects.	Responsibility Advocate for OSC to be accepted as a mainstream building approach.
Environment Sustainability	Opportunity Recognise OSC's predictability and consistency in compliances.	Responsibility Initiate reform to inspect and certify OSC processes off-site rather than completions onsite.	Responsibility Initiate reform to evaluate OSC processes under Building Sustainability Index (BASIX).	Opportunity To lower the carbon footprint of Australia's home building industries.	Responsibility Promote the advantages of OSC over conventional building methods.
Capital Investment	Responsibility Initiate OSC Specific regulations to boost investor confidence.	Responsibility Initiate State land guarantees that facilitate private capital partnerships.	Responsibility Implement clear legislation that provides confidence to invest in OSC processes.	Responsibility Provide Government subsidies to encourage investment in OSC.	Responsibility Making aware the benefits of OSC methods among institutional investors.

Table 5.2: Governing Side Stakeholder Opportunities and Responsibilities

There are numerous other stakeholders who can influence the successful adoption of OSC who are not represented in Tables 5.1 and 5.2. For example, architects and subcontractors can serve as industry experts to facilitate the successful adoption of OSC methods. However, in the absence of proper regulation and a strong industry association to advocate the benefits of OSC, these industry experts can also cause friction and nullify the potential benefits that OSC offers. Many stakeholders have a greater impact on a project-by-project basis and have less influence on the issues that CHPs confront in offering affordable housing options. CHPs seeking alternative building methods to satisfy their supply side goals will benefit greatly from an industry association that listens to the needs of supply side stakeholders and advocates for OSC adoption with governing bodies.

5.5 Conclusion

Even though this research only covers one project that was developed and two OSC attempts that failed to come to fruition, there may have been many other CHP attempts that were pursued. The case studies contribute to a better understanding of the future opportunities and challenges that CHPs may face when developing community housing development strategies based on OSC methods, where if the method is to succeed as an affordable alternative to conventional methods, *Supply Side* and *Governing Side* stakeholders must take the responsibility to facilitate change.

6 Research Conclusion

6.1 Introduction

Despite the fact that off-site constructed modules were used in Australia in the 1930s and were dubbed "slums of tomorrow" (Taylor & Gregory 1992), OSC has been accepted globally as a construction method for reducing construction time and cost of housing supply, while also improving housing quality and building industry performance through the use of a lean manufacturing approach (Steinhardt & Manley 2016; The Modular Building Institute 2010).

OSC can be credited with introducing lean principles and practises into the construction industry, which are based on the concepts of predictability and consistency. The transition to a manufacturing process in construction can provide significant time and cost savings to the residential construction industry. Despite the Commonwealth and State Governments emphasising the importance of planning to encourage more diverse types of housing (Economics References Committee 2015; NSW Department of Planning 2020; The Affordable Housing Working Group 2016), there has been little attempt made by all levels of Governments to try out new innovative methods of construction such as OSC to deliver affordable housing provisions.

Developers and builders in NSW have been using OSC methods in conjunction with conventional methods, which Steinhardt discovered in his comparative study with Sweden (Steinhardt et al. 2020). There are informal networking relationships between firms and peak bodies in Australia, according to Steinhardt. These industry associations serve as a forum for informal interaction among those whom Steinhardt refers to as "Industry Actors" who decide the fate of OSC adoption.

Learnings from Steinhardt's observation was applied to this study in identifying who these actors were. The information in Tables 5.1 and 5.2 was compiled by broadly categorising these actors as Supply Side Stakeholders and Governance Side Stakeholders based on their key role. An entity with a public interest in resolving the housing crisis at its core can act as a pivotal industry body, collaborating with scientific research organisations, universities, industry bodies, and experts in the field to have OSC recognised by the state as an alternative to conventional building methods.

Organizations such as Landcom, the NSW Government's land and property development organisation, could well work with The Commonwealth Scientific and Industrial Research Organization (CSIRO) to establish a way forward that could facilitate affordable housing delivery using OSC techniques.

This will facilitate industry change, upon which policy and building regulations in the context of OSC can be built upon. The construction industry will have the confidence to openly offer OSC as part of their product offerings, which can also be used as an alternative construction method to conventional methods. This will allow community housing providers to leverage the benefits of both methods to diversify their asset portfolio and serve the housing needs of a larger community.

When it comes to the discussion of using OSC methods for residential construction, the research finds a love-hate relationship among stakeholders. The results of the interviews indicate that while some want to reap the benefits of OSC in secret by combining the benefits of lean manufacturing that OSC provides with conventional on-site construction methods, others want OSC to be legitimised and recognised as an alternative to conventional building methods. Because of the time constraints associated with conventional building methods, OSC has been able to project itself as a niche in certain Australian markets where affordability has been overlooked. The global enthusiasm in literature and industry publications for OSC as an alternative to conventional construction methods has resulted from the demand for the construction industry to be lean and green in the face of rising material costs and a skilled labour shortage. This has resulted in a shift towards OSC techniques in some parts of the world.

Housing industry experts and building regulators agreed that if we were to address future housing needs in an era of limited resources, a different approach, such as OSC, would need to be considered by the building industry. It is only through the maturity of the industry in OSC that we will be able to provide housing that is both timely and affordable.

6.2 Findings of research questions

Using the research questions listed below the study fills a gap in the literature by examining Supply Side and Governing Side Stakeholder perspectives, the presence of policies and planning, and operational side influencers that provided opportunities and challenges in treating OSC as

an alternative to conventional construction methods to deliver Social and Affordable Housing in Australia.

1. What funding and housing delivery challenges do Community Housing Providers in New South Wales face?

The conclusion to this research question was reached by comparing the findings of the literature to the findings of the field study, which included interviews with community housing sector professionals and housing industry regulators. While some believed that the free-market ideology of "letting the market decide," influenced by neoliberal views, had created inequalities in society, others believed that many ruling governments distanced themselves from social housing responsibilities, devising policies that delegated these responsibilities to state and local government (LG) jurisdictions, and that this had harmed CHPs' efforts to deliver new housing stock.

CHP housing policy advocates believe that their efforts to meet affordable housing needs have often been impeded by the rise in NSW house prices caused by market speculation and state regulations that favour market housing. Professionals in the community housing sector and housing industry regulators in NSW agreed that the government's lack of a National Housing Strategy has undervalued CHP efforts to provide social and affordable housing, with each State and Territory developing their own regulatory framework for funding and planning towards their social and affordable housing cause.

With the Commonwealth's shifting stance on social housing, many thought the State had delegated responsibility for community housing supply to local governments via local planning provisions, with CHPs increasingly being asked to provide housing. There is no specific state planning guideline for community housing delivery, and CHPs have little sway in NSW policy discussions about the supply of social and affordable housing. According to CHPs, the community housing industry and its members have been unable to expand operations due to uncertainty in supportive policy.

CHPs in NSW welcomed the establishment of NHFIC as a significant policy development, but they felt the Commonwealth Government did not make a significant enough effort to reduce pressures on the delivery of affordable housing. The complex funding mechanism of NHFIC,

according to CHPs, did not compensate for the need for a supply-side subsidy that addressed the state's high land prices.

The NSW State Government used the public housing transfer model to provide a revenue pathway and expand opportunities for CHPs. The costs of maintaining already depleted public housing assets were viewed as a poisoned chalice rather than a chance for growth in the community housing sector. It was thought that by withholding the State's ownership transfer of these public assets from CHPs, CHPs would have little opportunity to borrow funding against this managed stock to enable new developments.

With some of the issues raised and the potential opportunity for housing in NSW, there is a case to be made for a new innovative building approach.

2. What are the potential benefits and drawbacks of using off-site construction (OSC) for residential developments in New South Wales?

To determine the potential benefits and drawbacks of using off-site construction (OSC) as a mainstream residential construction method in the Australian context, particularly in NSW, interviews with participants from the residential construction industry, development teams working for CHPs, and construction industry regulators, including local government authority, were conducted. In determining the extent of OSC adoption participants' perspectives were framed against global advancements in construction methods and technologies, as well as an eight-point vision statement outlined by Australia's Cooperative Research Centre for Construction.

Global examples of transition to modern construction approaches were examined to determine what motivated their shifts to OSC and whether the same can be applied in the Australian context. Despite regional differences and economic diversity of OSC adapters and non-adapters, countries that wanted to solve their housing needs frequently endorsed off-site construction techniques using Government-led building programmes to encourage research and innovation in the sector. This was not the case in Australia.

It was discovered that, with a global housing affordability crisis, the residential construction industry was undergoing rapid change, when Australia was looking to OSC as a solution for

portable structures rather than a method to manufacture permanent homes. Regional differences in OSC method adaptation were observed between the two major states of New South Wales and Victoria, with the latter having more public and state government acceptance for OSC methods. Because OSC manufacturing was based on cost, design options, and design flexibility, NSW developers believed that very few people in the Sydney residential development market considered OSC methods for housing. It is assumed that developers were more concerned about the radical change OSC could bring to their current operating business model, which relied on subcontracting processes on-site.

The lack of a strong regulatory framework in NSW, that was supported by OSC specific building codes and a chain of verification, contributed to developers' fear of managing an OSC workflow. There were no government initiatives to establish OSC as a mainstream building technique. Australia has yet to experience a modernisation trend in construction. Literature shows that the digitalisation of construction products and processes, along with the emergence of new technologies and materials, has caused disruption in the global construction industry. Regulators acknowledge that Australia has been slow to follow suit due to the tight regulatory constraints that govern the construction industry.

Despite the list of opportunities and drawbacks identified in this research OSC provides an opportunity to move away from outdated construction work practises, that can allow new entrants to engage in innovative solutions that can give them a competitive advantage over traditional development methods. A few companies in NSW have recognised the potential of OSC and are offering their services to a niche market. Many of these companies refused to share their techniques or knowledge with this research. In meeting the pricing demands for market housing in NSW some large residential developers have discreetly used OSC with conventional building methods to gain cost and time advantages in their developments.

Many participants believed that implementing a state-led development initiative using innovative OSC methods, as well as legitimising the regulatory framework governing OSC, could serve as a catalyst for a home-grown industry, with private developers forced to follow suit in order to compete in the residential housing sector. This has the potential to remove some of the entry barriers erected by the industry's dominant small group of large developers and pave the way for off-site construction (OSC) to be a development alternative for Community Housing Providers (CHPs) in New South Wales.

3. Can off-site construction (OSC) be a development alternative for Community Housing Providers (CHPs) in New South Wales, and what opportunities and responsibilities can stakeholders take to initiate transformation?

The standard offerings of CHPs, as well as the repetitive feature of OSC in factory conditions, can benefit in the retention of a consistent workforce capable of managing set quality standards, economies of scale, and less waste. Because of its immaturity and legitimate acceptance as a mainstream building method, the project outcomes expected of a CHP builder differ greatly from those expected of a developer building market housing. Some believed that the CHP's goal to design-out maintenance would fall short, while others believed that ongoing maintenance for OSC methods would be no different than for conventional construction methods.

The question seeks to ascertain whether OSC characteristics can aid in CHP development initiatives, as well as how mature Australia's construction industry is in passing on the benefits of OCS to CHPs. This was accomplished by reviewing the opportunities and challenges faced by CHPs in three case studies where OSC methods were attempted. Although the results of these efforts fell short of expectations, many participants agreed that an innovative construction approach can broaden the strategic purpose of CHPs by allowing them to operate at a scale that provides operational efficiencies and a return on investment.

Despite the opportunities that OSC could provide for CHPs, the industry is still in its early stages, and OSC has yet to be tested in Australia for multi-story community housing developments. Case Study 1 discusses the difficulties in sourcing volumetric modules from overseas, as well as the incompatibility of building regulations with modern construction trends where a multi-story element was present.

Case Study 2 highlights a developer's reluctance to adopt OSC methods after being forced to over-engineer their product offerings to meet the NSW Residential Apartment Buildings Act 2020. Meeting these standards would have not only increased costs but also created a logistical nightmare for the project. As a result, the developer was unwilling to give up their market leadership in conventional building methods.

Case study 3 demonstrated that the lean manufacturing feature that benefited the automobile industry cannot be frequently applied to repetitive OSC building elements. The CHP's revised building features did not necessitate a repeatable building approach.

CHPs, according to housing policy advocates, are subject to a regulatory system that requires them to meet a wide range of performance outcomes on assets they own. In order to meet these demands, they believed that the prefabricated nature of OSC could help CHPs provide timely, cost-effective results with minimal disruption to tenants. They claim to pursue new initiatives in response to funding opportunities provided by state and federal governments. When compared to state-run organisations, CHPs that received capital injections in the form of land, operating subsidies, and tax breaks for development demonstrated efficiencies and savings in literature.

By addressing these research questions, the study identified the benefits and drawbacks of using OSC for residential development in Australia, with a focus on New South Wales. These opportunities and challenges were presented to CHPs who were interested in OSC as a development option. Some CHPs attempted to use OSC methods, and the research presents stakeholder experiences from these projects as case studies, which provide valuable insight.

Given the savings and efficiencies that OSC can provide CHPs, the study identifies that it is necessary to simplify and improve the policies and regulations that govern residential development, particularly in the social and affordable housing segments where development subsidies are limited, and the quality standards of housing assets are critical.

6.3 Further study

This thesis provides a preliminary overview of the potential that OSC may provide stakeholders, as well as a guideline for the roles that each stakeholder can play in enabling OSC emerge as a form of construction for housing in NSW. In a broader economic framework, there is an opportunity to do more research to see if OSC housing, given the correct regulatory setting by the State, can serve:

- Australia's aged population as an affordable alternative to downsize in locations they prefer. I.e., Multi-generational housing.

- Can OSC provide opportunity for private home ownership in unaffordable suburbs?
- Could OSC housing act as a second dwelling for an expanding family or support low-income households to generate additional income? and finally
- Can OSC prevail as an opportunity for housing providers and philanthropic organisations to fight homelessness?

The outcomes of this study were designed to present a real-world effect of policy reform, as well as a conceptual contribution that recognises OSC as a type of construction for the delivery of affordable housing. The thesis conducted case studies in New South Wales to generate findings about the opportunities and barriers to OSC adoption. Some of the research findings could spark further study with the aim of a national overhaul of legislation and planning regulations to make OSC approaches more applicable across the country.

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Appendix 1

Ethical Approval

20/04/2021

Dear Associate Professor Ruming,

Reference No: 52021959426328

Project ID: 9594

Title: Off-site manufactured housing in NSW: opportunities and barriers for affordable housing provision

Thank you for submitting the above application for ethical review. The Arts Subcommittee has considered your application.

I am pleased to advise that ethical approval has been granted for this project to be conducted by Associate Professor Kristian Ruming, and other personnel: Mr Dilakshan Tampoe.

This research meets the requirements set out in the National Statement on Ethical Conduct in Human Research 2007, (updated July 2018).

Standard Conditions of Approval:

1. Continuing compliance with the requirements of the National Statement, available from the following website:
<https://nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018>.
2. This approval is valid for five (5) years, subject to the submission of annual reports. Please submit your reports on the anniversary of the approval for this protocol. You will be sent an automatic reminder email one week from the due date to remind you of your reporting responsibilities.
3. All adverse events, including unforeseen events, which might affect the continued ethical acceptability of the project, must be reported to the subcommittee within 72 hours.
4. All proposed changes to the project and associated documents must be submitted to the subcommittee for review and approval before implementation. Changes can be made via the [Human Research Ethics Management System](#).

The HREC Terms of Reference and Standard Operating Procedures are available from the Research Services website:
<https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics>.

It is the responsibility of the Chief Investigator to retain a copy of all documentation related to this project and to forward a copy of this approval letter to all personnel listed on the project.

Should you have any queries regarding your project, please contact the [Faculty Ethics Officer](#).

The Arts Subcommittee wishes you every success in your research.

Yours sincerely,

Dr Mianna Lotz

Chair, Arts Subcommittee

The Faculty Ethics Subcommittees at Macquarie University operate in accordance with the National Statement on Ethical Conduct in Human Research 2007, (updated July 2018), [Section 5.2.22].

Appendix 2

Research Introduction

Email to Participants

Participant Name

Position

Name of Organisation

Dear Participant,

My name is Dilakshan Tampoe. I am a research student in Geography and Planning in the School of Social Sciences at Macquarie University Sydney.

I am writing to invite you to participate in a research project that explores opportunities and barriers for off-site constructed housing in NSW. The research is conducted as part of my Master of Research, under the supervision of Associate Professor Kristian Ruming.

I am interested in exploring key stakeholder perceptions and experiences of off-site constructed housing in NSW, specifically as a form of construction which might benefit community and affordable housing providers.

As the head of policy for the Community Housing Industry Association, your contribution to this project will give me valuable insights in why the residential construction industry in Australia has, to some extent, been hesitant in adopting off-site constructed housing, and if state policy or local planning had been restricting this form of construction.

I am contacting you as it is vital that the perspectives and objectives of community housing providers and industry associations are included in this analysis.

Participation would involve an interview of up to 60 minutes and would explore your experience and views if off-site construction techniques should be a part of NSW's housing delivery strategy. The interview would be conducted at a time convenient to you.

A letter of invitation containing a *form of consent* and *indicative interview questions* has been attached to this email. The signed consent can be collected at time of interview or emailed in return.

Regards,

Dilakshan Tampoe

Student [REDACTED] | Master of Research
Macquarie University | mq.edu.au
Faculty of Arts | Geography & Planning
Mobile: [REDACTED]

Appendix 3

Research Invitation & Letter of Consent



MACQUARIE
University
SYDNEY · AUSTRALIA

Associate Professor Kristian Ruming

Discipline Chair
Discipline of Geography and Planning
Macquarie School of Social Sciences
Faculty of Arts
Macquarie University
NSW 2109 Australia
T: +61 (2) 9850 9314
E: Kristian.ruming@mq.edu.au

Participant Name

Position

Organization Name

Address

24 February

Dear Participant,

Off-site constructed housing in NSW: opportunities and barriers for affordable housing provision

Despite the internationally identified merits of off-site construction (OSC) as a possible solution to the provision of affordable housing, the use of OSC to provide new affordable housing in Australia has been limited. This research intends to explore why this is the case, using New South Wales as a case study. This research will explore the barriers and opportunities for expanded OSC housing provision, specifically as a form of construction which might benefit community and affordable housing providers.

The aims of this research are threefold. First, the project will conduct a review of the planning and regulatory framework surrounding OSC housing. Second, the project will look at international case studies and identify how OSC has been used internationally to provide affordable housing. Third, the research will explore the perceptions and experiences of key stakeholder groups, including planning practitioners at local and state government level, community housing providers exploring OSC as an innovative housing option, and manufacturers of off-site housing.

The study is conducted by Dilakshan (Dilak) Tampoe, as a part of his Master of Research within the Discipline of Geography and Planning at the Macquarie University, under the supervision of Associate Professor Kristian Ruming. This research has not been funded by any agency in the public, commercial, or not-for-profit sectors. You are invited to participate in this research as you hold expertise in policy governing community housing. Participation in this study is entirely voluntary and you can withdraw your participation at any time without having to give a reason and without adverse consequence. Participation in this research will involve an interview of up to one hour in length. The interview will be conducted at a time and location convenient to you.

No individual will be identified in any publication of the results. A pseudonym will be assigned to provide anonymity to research participants. Only members of the research team and professional transcribers will have access to the original data generated through this research. A summary will be made available to all participants at the end of the project.

We look forward to your participation. Please feel free to contact me if you have questions about this research [REDACTED]

Thank you for considering participating in this research project.

Regards,

Dilak Tampoe

Kristian Ruming



I, _____, have read and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence. I have been given a copy of this form to keep.

Participant's Name:

Date:

Participant's Signature:

Preferred online interviewing platform:

Zoom

Microsoft Teams

Investigator's Name:

Date:

Investigator's Signature:

The ethical aspects of this study have been approved by the Macquarie University Ethics Review Committee (Human Research) Project ID: 9594. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Ethics Review Committee through the Director, Research Ethics (telephone 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.



Indicative Questions

- How do you rate your organisations level of awareness and expertise around off-site construction as an alternative solution to onsite constructed methods used in the delivery of housing?
- Are you aware of any residential project where the complete project or a component of the project used off-site construction process for the placement of housing onsite? What is your opinion about the outcome of such project?
- If this construction method proves productive and cost efficient what is your opinion about the placement off-site constructed housing as an affordable housing solution in low density unaffordable suburbs where land use is scarce and restricted?
- Are you aware of any legal framework that supports or restricts off-site constructed housing in Australia?
- In your opinion, what style of dwellings is off-site construction techniques most suitable for? What aspects of off-site design and construction do you consider critical in meeting development approvals?
- In what ways can different levels of government and organizations representing the construction industry can promote the utilization of off-site construction as a part of NSW's housing delivery strategy?
- Does the NSW housing policy and planning guideline provide sufficient flexibility to allow the approval and construction of off-site constructed housing?
- What are the most common dwelling styles where off-site construction was used in place of onsite construction methods in NSW?
- What areas of the building code and planning regulations provide opportunities and barriers to off-site constructed housing projects in NSW?
- Have there been times when the approval of off-site constructed housing restricted by location-based demands or community concerns? How were these issues addressed?
- How are development applications (DAs) for off-site constructed housing assessed by local councils and does this differ from onsite constructed housing?
- Due to the standardised nature of off-site constructed housing, do you feel that development applications can be reviewed under NSW Complying Development Checklist (CDC) which can be fast tracked?

Appendix 4

List of Interview Questions

General questions for all participants

- How do you rate your organisations level of awareness and expertise around off-site construction as an alternative solution to onsite constructed methods used in the delivery of housing?
- Are you aware of any residential project where the complete project or a component of the project used off-site construction process for the placement of housing onsite? What is your opinion about the outcome of such project?
- If this construction method proves productive and cost efficient what is your opinion about the placement off-site constructed housing as an affordable housing solution in low density unaffordable suburbs where land use is scarce and restricted?
- Are you aware of any legal framework that supports or restricts off-site constructed housing in Australia?
- In your opinion, what style of dwellings is off-site construction techniques most suitable for? What aspects of off-site design and construction do you consider critical in meeting development approvals?
- In what ways can different levels of government and organizations representing the construction industry can promote the utilization of off-site construction as a part of NSW's housing delivery strategy?

Specific questions for Process Owners - Builders, Developers and current offsite manufacturers.

- Based on the projects completed by your organisation, what proportion of the completed projects does offsite constructed components account for?
- Do you see a trend in current onsite construction methods moving towards off-site construction?
- How flexible is your organisation to change over from a project-based construction workflow to a standardised process-based manufacturing workflow of houses?
- What are the barriers and opportunities that your organization has/will encounter when delivering off-site constructed housing?
- Can manufacturing efficiencies and standardisation in off-site constructed housing provide a more affordable product offering while securing the same level of profits as onsite projects?
- How should the Australian building code be applied to off-site constructed housing techniques? How should the codes be different from the ones currently adopted for onsite building methods?
- What are your views on NSW housing policy and planning guidelines? Is the NSW regulatory framework a barrier or an opportunity in offering affordable offsite constructed housing?

Specific questions for Regulators - Government Policy advocates, NSW Planning Authority and Local councils.

- Does the NSW housing policy and planning guideline provide sufficient flexibility to allow the approval and construction of off-site constructed housing?
- What are the most common dwelling styles where off-site construction was used in place of onsite construction methods in NSW?
- What areas of the building code and planning regulations provide opportunities and barriers to off-site constructed housing projects in NSW?
- Have there been times when the approval of off-site constructed housing restricted by location-based demands or community concerns? How were these issues addressed?
- How are development applications (DAs) for off-site constructed housing assessed by local councils and does this differ from onsite constructed housing?
- Due to the standardised nature of off-site constructed housing, do you feel that development applications can be reviewed under NSW Complying Development Checklist (CDC) which can be fast tracked?

Specific questions for End Users - Non-Government organizations and community housing providers.

- Has off-site constructed housing been considered as form of affordable housing alternative by your organization? What are the characteristics in off-site constructed (OSC) housing that makes it an appealing form of affordable housing?
- What has been your organisations most successful experience or development challenge in using off-site construction methods?
- How did you identify and engage the manufacturer of OSC housing? In comparison to onsite construction, how different was the compliance process that governed contracts at each stage of manufacture?
- Did your organization experience any project funding/delivery barriers for OSC projects because of local or state government not having a pre-defined approval process for OSC in place?
- Do you see a future in off-site constructed housing as a solution to providing affordable housing in NSW? What is the type of policy and regulatory changes you propose in accommodating off-site manufacture as a part of NSW's housing delivery strategy?

