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Preface

Secure, suitable, and affordable housing is fundamental to the health and well-being of people and to the smooth functioning of societies. Yet around the world, in developing and advanced economies alike, cities are struggling under pressure from population growth to meet that need. By 2025 it is estimated that 1.6 billion people – a fifth of the world's population – will lack access to secure, suitable, and affordable housing.

This joint APNHR and AHRC conference is focused around the theme of *Smart and Sustainable Housing Futures*; a term which has notably gained the attention of policy makers' circles in the last few years. *Smart and Sustainable* in terms of demonstrating good practice in housing finance, design, construction, and operation making homes more socially, environmentally and economically sustainable.

The conference provides a special forum for researchers, policy makers and practitioners to share their knowledge and experience that will be of benefit to academic institutions, government departments, and private sector organisations. *Smart and Sustainable futures*' issues must be examined in an integrative and holistic way to address the different sustainability pillars taking into account future studies and changes within the global context. This proceedings contain a collection of peer-reviewed papers covering broad areas of current and emerging issues which will enable affordability and liveability, while at the same time accelerating the speed, quality and equity of housing delivery in the Asia Pacific region.

The Conference Organising Committee hopes that you find the conference beneficial and that you enjoy your stay in the City of the Gold Coast, Australia.

Professor Sherif Mohamed

On behalf of the

Conference Organising Committee

June 2018

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TINY HOUSES: PLANNING FOR AFFORDABILITY AND INCLUSION

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Abstract
The tiny house movement is increasingly topical, and tiny houses have been mooted as an innovative and sustainable way to improve urban housing affordability. But how valid is this claim? Few if any scholarly studies have investigated the tiny house phenomenon in any depth. This study used a combination of quantitative and qualitative methods to analyse the tiny house movement in Australia. An online survey was conducted in 2015 and again in 2017, as well as a series of semi-structured interviews with tiny house dwellers and tiny house builders. Finally, a case study of South East Queensland Australia investigated local government planning schemes and whether these permitted either temporary types of tiny houses (on trailers) or permanent tiny houses (as in granny flats). Interest in the tiny house movement had increased significantly from 2015, with more people living in tiny houses, and a number of builders now building tiny houses (mostly on wheels). Interestingly, there was high interest in tiny houses by single women aged over 50; as well as younger couples in their 20s. Local governments varied widely in their attitudes to tiny houses, with only a few accepting or even recognising that tiny houses exist as a legitimate housing form. The research concluded that tiny houses are a sensitive and innovative way to increase urban density and improve affordability. To move forward however, it is essential that local and state governments modify their planning schemes and local laws, with appropriate conditions, to permit this type of housing in Australian cities.

Keywords: urban, housing affordability, micro dwellings, sustainability.

INTRODUCTION

The continued rise in house prices is a perennial issue in countries such as Australia, the United States and the United Kingdom (CEDA, 2017, Anglicare Australia, 2017). The gap between housing demand and supply, particularly in major urban areas is seemingly resistant to any number of policy measures (Senate Economics Reference Committee, 2015, Pawson et al., 2015b, Worthington, 2011). Concurrent with the rise in house prices has been a rise in house size, particularly of large, detached houses on the expanding suburban outskirts of capital cities. Australia now has some of the largest and most unaffordable housing in the OECD (Cox and Pavletich, 2015). A recent rise in popularity of what has become known as the tiny (or micro) house movement has been mooted to address housing affordability, unsustainable housing and suburban sprawl (Shearer, 2015b). But realistically, can tiny houses offer a part solution to these issues?

Urban housing supply and demand is a complex and multi-faceted issue; related to a combination of a sustained demand for housing in relatively close proximity to the CBD, a lack of affordable land, inflexibility of planning schemes and tax incentives such as negative gearing (Worthington, 2011). Tiny houses can potentially increase densification without driving up prices. This paper seeks to explore the extent of the tiny house movement in Australia, and by doing so, add to knowledge about a largely unstudied phenomenon. It also aims to investigate the potential of tiny house living to address aspects of urban density, housing affordability, and environmental sustainability.

The paper addresses three main questions: 1) what are some common characteristics of tiny houses and the tiny house movement in Australia? 2) What drivers and barriers are characteristic of the tiny house movement? 3) Are tiny houses a realistic approach to housing affordability and sustainability or just another niche market? There is a paucity of scholarly research on the tiny house movement, but the paper builds on previous studies by the authors as well as a literature review on housing affordability in general. It reports on the results of a large scale survey of tiny house advocates in Australia on why they have or are considering building a tiny house, and their reasons for doing so.

THE TINY HOUSE MOVEMENT AS A RESPONSE TO THE HOUSING AFFORDABILITY CRISIS

The tiny house movement is a relatively new phenomenon, and is most apparent in developed nations; and in particular, English speaking ex colonies of the UK, such as the USA, Australia and Canada. These countries share similar features, large and unaffordable housing and high degrees of urban sprawl. All 35 major urban markets in Australia are considered unaffordable, and it is consistently ranked as either first or second in mean house size in the OECD (Cox and Pavletich, 2015, Worthington, 2011, Yates, 2008). Australian cities also have some of the lowest densities in the world, with Melbourne, Sydney and Brisbane in the top 50 global cities for land area, (Demographia, 2017, Hunn, 2017).

Unaffordable housing has many economic, social and environmental impacts, including the increasing economic stratification of cities, inability of workers to live in proximity to employment, exacerbation of traffic congestion and pollution from private vehicle use, and increasing economic insecurity and risk of potential homelessness for highly leveraged homeowners or renters (Dodson and Sipe, 2008, Yates et al., 2006). These issues are acknowledged by policy makers, city managers and housing providers yet attempts to address rising house prices have had little or no impact. Unaffordable housing is a complex and multi-faceted issue, with both demand and supply-side drivers.

On the demand side, the majority of the population reside in urban areas (85%) and employment is centralised in the capital cities, as are public transport and social and cultural activities. Exacerbating this demand are easily accessible mortgage finance, tax incentives such as negative gearing, and a 'strong cultural preference for owner-occupied detached houses' (Worthington, 2011, Pawson et al., 2015a). On the supply side, are slow and inflexible planning processes (particularly at the Local Government Authority (LGA) level), a lack of infrastructure and overly onerous development assessment requirements (Cox and Pavletich, 2015). LGA planning schemes are not always supportive of non-normative developments, as are tiny houses (Shearer et al., 2016). The scholarly consensus on unaffordable house prices in Australia attributes it primarily to demand-side drivers (Pawson et al., 2015a, Cox and Pavletich, 2015). Demand-side drivers are major contributory factors to price rises, but supply side drivers are more pertinent to tiny houses, particularly inflexible and complicated LGA planning schemes.

It must be emphasised that unaffordable housing is equally if not more applicable to renters. Higher proportions of income are paid in rent, with low income renters sometimes spending 60% of more of their total income on housing (Yates, 2008). The rental market is also very insecure, with leases over 12 months a rarity, and multiple restrictions, such as on pets, the norm rather than the exception.

Unaffordable housing is also linked to house size, although the relationship is not linear, as larger houses are often more cost effective per square meter, because of economies of scale and cheaper materials available to large building contractors. Generally speaking in Australia, the larger 'McMansion' houses are situated in the middle and outer suburbs of the cities, and often in master planned estates by large development companies. These very large suburban houses result from cheaper land, the ability to own a detached house with a backyard, developer subsidised finance, sales pressure in display villages and social norms within these estates.

Large houses far from the city can have economic, social and environmental costs including increased Greenhouse gases (GHGs) from private vehicle use, traffic congestion and time spent commuting, economic polarisation of the population, resource use from construction and infrastructure, and environmental degradation from land clearing. Clearly, increasing the density of areas closer to the city and reducing the size of houses, can save significant amounts of resources and energy, as well have substantive social benefits. So how can tiny houses be part of the urban density mix?

The academic literature on tiny houses has to some extent, grown since 2015 (Shearer, 2017), but it is still limited. There are significantly increased numbers of popular media articles about tiny houses, in all types of media, including social media. For example, Australian tiny house Facebook Groups have increased in number from two (2015) to approximately 15 (2017) and member numbers are relatively large; the original Tiny House Australia Group and Page now has over 47,000 members (THA, 2017).

History of tiny houses

The antecedents to the tiny house movement can be traced back to the 1850s, when Henry David Thoreau, in the book 'Walden', promoted self-sufficiency and elimination of debt by building a small house (Anson, 2014, Diguette, 2017, Ford and Gomez-Lanier, 2017, Thoreau, 1854). Later, in the 20th Century, prefabricated tiny houses were built after WWII to ease housing shortages, and in the 1960s, the environmental and alternative lifestyle movement saw a resurgence of the trend (Bares et al., 2017).

The tiny house on wheels trope originated around 1998, in response to planning restrictions, housing affordability and a desire to live more sustainably (Mutter, 2013).

Early adopters included the designer Jay Schafer, founder of the Tumbleweed Tiny House Company, the writer Lloyd Kahn and the architect Sarah Susanka (Mitchell, 2014, Bares et al., 2017). The primary reason for building on wheels was to circumvent planning restrictions, as the USA has minimum house size restrictions. By placing the house on a trailer bed, classified it as a vehicle which did not have to comply with planning law.

Tiny houses are not a homogenous housing form, and given the contemporaneity of the movement, they are not easily classifiable, particularly within planning schemes. Generally speaking, they tend to be either fully mobile (on a trailer), partly mobile (on skids or otherwise relocatable), or fixed (as in a granny flat) (Shearer & Burton, in press). They can also be more environmentally sustainable and cheaper to build than a standard house, and design is considered very important, especially as most early tiny house builders were architects (Mitchell, 2014).

Interest in tiny houses in Australia only began around 2010, (see Figure 1). This has risen dramatically from around 2012, and continues to grow (Google Trends, 2018). Social media activity has risen significantly, with a number of active tiny house Facebook Groups in Australia, some of which have members in the tens of thousands (Tiny Houses Australia, 2017). New specialist tiny house builders are appearing almost daily, it is reported in the mainstream media on almost a weekly basis, and on 13 September 2017, someone even stole one (Shearer, 2017).

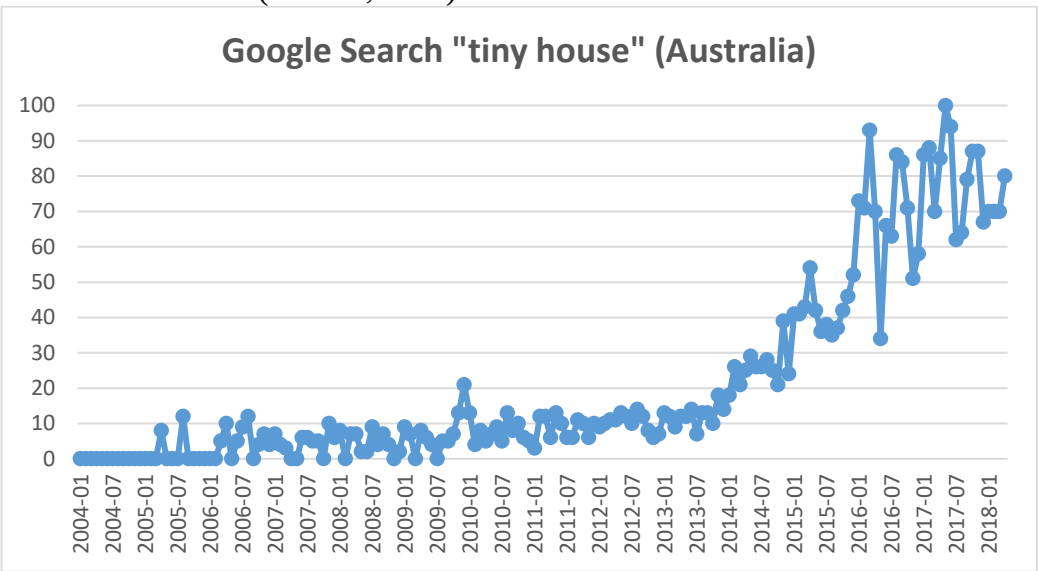


Figure 1. Google Trends Search ‘Tiny House’ Australia only. 2012 to 2018

Environmental Sustainability

Large detached houses and high rise apartments use significant amounts of water and energy in their construction, ongoing operation and eventual demolition (Kilman, 2016, Wentz and Gober, 2007, Wilson and Boehland, 2005). Residential high rises use greater amounts of water and energy per capita than detached houses (Pullen et al., 2006). Traditional building methods use large amounts of resources, and creates waste at all stages of the construction lifecycle, and building operations produce significant GHG emissions. Indeed, housing is second only to transport for GHG emissions (Jones and Kammen, 2011, Carlin, 2014b). Environmental impacts of housing include also the secondary impacts of poor design of the house and the surrounding managed landscape. Finally, unaffordable housing can increase traffic congestion, fragmentation of landscape and increase GHG emissions from private vehicle use.

Tiny houses on the other hand have a smaller ecological footprint, are often part or fully constructed from recycled or renewable materials, and are often off-grid (Kilman, 2016), so use proportionately less resources (Tiny House Build, 2014, Carlin, 2014a). Tiny houses also have secondary environmental benefits, tiny house dwellers frequently emphasize downsizing and minimising possessions, conscious consuming and the sharing of appliances, cars and other consumer goods. Living in an off-grid tiny house forces its residents to directly confront the often invisible use and waste of resources (Kilman, 2016, Anson, 2014). Moreover, the limited space means that they have to socialise and interact in community settings (Kilman, 2016).

Economic Sustainability

Since European settlement, Australian housing has been characterised by detached dwellings with a large backyard, reflecting cultural preferences and the desire for private space (Worthington, 2011). A large sprawled city with detached houses and a small, dense CBD remains the dominant urban morphology in Australia, despite government policies to encourage densification. The mean size of new houses in Australia is around 241m^2 (Cox and Pavletich, 2009, Cox and Pavletich, 2015, Worthington, 2011, Yates and Gabriel, 2006), and most detached houses are 3 bedrooms or larger, while inner city apartments are 2 bedrooms or smaller. This tends to limit apartment living to singles or couples without children, the most common demographic in the tiny house movement.

Neither large houses in the suburbs or inner city apartments are affordable; Land prices are extremely high especially in inner city areas which are mostly all developed, and zoned for high density living. In the suburbs, planning regulations restrict the types of dwelling, and other planning requirements, infrastructure charges and taxes add further to the cost of land and construction.

Many tiny house advocates express the desire for a smaller house that is owned rather than rented, affordable and owner-built (Shearer, 2015a). They express desires to reduce debt, to transition from full time to more flexible work or retirement, to let to family or even tourists, and to avoid homelessness. Indeed, the strongest drivers for tiny house living are economic (Shearer, 2015a), and this is supported by other studies that indicate the 'biggest incentive for living tiny is saving money' (Kilman, 2016).

But are tiny houses more affordable than standard houses? They use fewer building materials, often use recycled or bartered products and save on labour, being largely owner-built (Kilman, 2016), but per square meter, tiny houses can cost *more* than standard houses. Generally speaking, the larger the house, the cheaper it is per square meter, particularly if built by a project builder. Also tiny houses are usually built for cash, so it is difficult to estimate true building costs, especially labour.

The tiny house market in the USA is more mature, with multiple tiny house manufacturers. These ready built tiny houses range upwards from around US$50,000; slightly more expensive per square meter than a standard project house (Kilman, 2016). In Australia, the relocatable/granny flat/ studio market is relatively mature, particularly in NSW, and such dwellings can be purchased from about $15,000 (mostly in kit form). Tiny houses on wheels (THoWs) are increasingly available commercially in Australia, but the market and cost varies widely.

Design

Finally, tiny houses are strongly differentiated from other forms of smaller housing by their emphasis on architecture and design (Ford and Gomez-Lanier, 2017). Tiny houses can be viewed as intentional dwellings with 'a deliberate use of space, materials, light

and function' (Mitchell, 2014). They are frequently unique, beautiful and creative.

The tiny house movement is also strongly Do It Yourself (DIY), with design and construction commonly undertaken by an individual intending to live in the tiny house. It can also be communitarian, with groups of people working and sharing building tools and materials. Interestingly, and unlike most other construction, more women than men build their own tiny house (Mitchell, 2014, Tiny House Build, 2014).

Many effective tiny houses incorporate design principles from caravans, boats and small dwellings in places such as Japan. In suitable climates, tiny houses include outside living areas such as decks, for entertainment and privacy. In cooler and wetter climates however, tiny house dwellers may be forced to remain indoors or to escape 'cabin fever', conflict and lack of privacy by going to public spaces such as coffee shops or libraries.

Design options also take into account the eventual users of the tiny house, and the archetypal tiny house on wheels with a loft bedroom has accessibility issues, especially for older or mobility impaired people. Their small footprint and room size is also often impractical for those using wheelchairs, strollers or walking aids. Nor are they suited, unless with outbuildings, for those requiring storage or creative space.

Tiny houses are suited only to specific demographics such as singles or couples, as they are too small to suit the archetypal nuclear family. Nor are they suited to group living, unless part of a tiny house community. Living in very small spaces requires sacrificing many things taken for granted in countries where people are used to large private spaces.

Where do you put tiny houses?

THoWs were first developed as a counter to planning restrictions, such as minimum house size codes. According to the International Residential Code (IRC) for example, at least one room should be larger than 120 square feet, with others at least 70 square feet (Kilman, 2016, Nonko, 2016)[1]. Onerous planning restrictions, complexity and cost are the greatest barriers to tiny houses (Ford and Gomez-Lanier, 2017, Shearer, 2015b).

Australian planning schemes and building codes mostly do not restrict house sizes, but do restrict the size of secondary dwellings, and lot coverage. Planning schemes have significant inconsistencies, differing between LGAs, and within LGA development zones. Secondary dwellings are accepted in most planning schemes, subject to any setbacks and overlay zones that may exist, though they can be expensive to construct. THoWs are not permitted in most urban LGAs in Australia, and are considered caravans, with restricted periods of occupancy. There are currently no provisions in legislation for parking your own 'house' on someone else's property and paying rent.

The Building Code of Australia (MBQld, nd) does not define tiny houses, thus there are few controls on their construction, which has implications for health and safety. This nebulous legal situation leaves tiny house dwellers open to complaints from neighbours. For example a tiny house on wheels was parked in a backyard in inner city Brisbane until a neighbour complained. The Brisbane LGA issued an infringement notice on the owners, stating, '*…the siting of the THOW on the subject site constituted building work which is assessable development and that no development permit for building work had been obtained for the THOW*' (BDDRC, 2016). After legal action, and the Building and Development Dispute Resolution Committee ruled that that it was 'neither a building nor a structure (as defined)' thus did not constitute building works, and was considered a road

[1] The IRC now has a Tiny House Appendix Q which includes different provisions for tiny houses, although it is not yet in common use, having only been accepted in one US County and one State (ICC 2017. Overview of the International Residential Code® (IRC®). International Code Council.)

registered moveable dwelling. THoWs thus must comply with the transport regulations, with restrictions on length, width, height and weight.

So, where do you put tiny houses? As discussed, Australia's housing unaffordability is primarily an urban problem; 87% of the population live in urban areas with over two thirds living in the Capital Cities (ABS, 2017). With this in mind, Bares et al. (2017) identified a range of planning options whereby tiny houses can, with minor modifications, be situated in urban areas (Table 1).

Table 1: Tiny House Planning Options in Australia (based on Bares et al. 2017)

Option	**Benefits**	**Barriers**
Granny flat *Secondary dwelling close to existing house*	• Permitted planning schemes. • Can purchase in kit form • Adds to land value • Densification option LGAs • Larger than a THoW	• Requires ownership of the land. • Potential legal issues if house owner wants to relocate it • May incur substantial costs, infrastructure charges
Tiny lots *small freehold subdivided lots*	• Allows the ownership of land • Can build and let out • Allows infill development without high rises • Communal open space and facilities	• Currently not supported by most LGAs in Australia • Tiny lots not cheaper or have smaller houses • Potential issues re parking, needs sensitive planning.
Tiny villages *small houses on a lot*	• Resident owns property under a strata title • Can be let to others • Entry level ownership • Communal benefits	• Not currently supported in most LGAs in Australia • Needs sensitive planning of design, layout, access etc. • Land prices in urban areas
Tiny backyard leases *THOW in backyards*	• Property owner can get rent from the tiny house owner • Tiny house is mobile • Privacy for both parties • Good for THOW	• Unclear in most local laws • May need connection to infrastructure and services • Potential for conflict • Car parking in some areas
Tiny house parks *Similar caravan /trailer park*	• Suited to ageing caravan parks in Australia • Specific zone for tiny houses • Good for communal living	• Stigma about trailer parks • Caravan parks in desirable areas under development pressure • Why are THoWs different?

These options only require minor modification to most planning schemes, and some already exist (granny flats and residential parks). Some are more feasible, granny flats are already part of the urban landscape, but others less so, and for example, houses built on very small lots in high value areas are not necessarily small. It would take political will to modify planning schemes, but the continued house price rises could expedite this.

However, the most pressing barrier is likely not LGA planning schemes but the price of land. The 'highest and best use' of inner city land is for very dense housing or commercial purposes. Most Australian cities are low density however, Brisbane Queensland comprises 74% detached dwellings (.idcommunity, 2017), with mean lot size of around 600m^2, having substantial areas which could be utilised for granny flats or tiny backyard leases. Larger areas further out could be suitable for tiny house communities, and State owned land could be leased to a mobile tiny house community, as these can be moved if necessary, and do not require much infrastructure.

METHODOLOGY AND DATA

This study used an exploratory multi method approach including the results of past research on the subject (Shearer, 2015b, Shearer, 2015a). It used an online questionnaire survey and qualitative analysis of open ended survey questions, as well as content analysis of tiny house groups on social media (Facebook). The tiny house movement is still an area of emerging research (Mutter, 2013), but a literature review of the small number of academic, but mostly popular media sources, was also conducted.

Questionnaire Design

The survey consisted of 5 sections and 18 questions. Sections 1 and 2 were about the tiny house, and asked if a person had built or intended to build a tiny house, the builder, location and cost. The third section asked about the benefits of tiny houses, with the questions were in the form of standard 5-point Likert Scales ranging from 1- Strongly Disagree to 5- Strongly Agree. Most questions had an 'Other' section, to garner qualitative information. Section four asked instead about perceived barriers to building tiny houses, also in Likert scale, and the final section included demographic questions, and an open-ended other comments question. The survey was conducted by snowball sampling of known populations; it was posted as a link to Australian Tiny House Facebook groups, and sent by email to people interested in tiny houses. Statistical analysis included on the quantitative side; frequencies, crosstabs, correlations; and on the qualitative side, content analysis. Given the largely qualitative nature and non-random sampling methodology, no further statistical analysis was undertaken.

THE TINY HOUSE MOVEMENT IN AUSTRALIA: A SNAPSHOT

A total of 442 people completed the survey, almost eight times as many as the previous survey (56). Of the total, 369 useable survey responses were obtained (73 were eliminated due to insufficiently completing the survey.

Significantly more people were interested in tiny houses than in 2015, and in contrast to the very low numbers in the first survey, 14% (52) had either built or were in the process of building a tiny house, with another 68% (249) intending to build a tiny house. The vast majority (67%) of tiny houses were mobile to some degree (either fully mobile, on skids or otherwise relocatable). One third intended to build the tiny house themselves (or with a partner or friends) and, reflecting the growth of the movement, 24% (86) built by a tiny house builder (zero in the initial survey). Most people intended to fund their tiny house with cash (31%) or income from employment (31%).

The intended location of the tiny house had a bimodal distribution, being capital city urban (35%, 129) and 38% (138) rural residential/rural (no greater than two hours from a capital city). The other choices, remote, non-capital city, and no fixed location had less than 10% each. Of interest, 51% (185) said that they had built or wanted to build their tiny house on their own land, with about 16% (57) renting, and 16% (37) did not know. A small majority (25%, 88) preferred to build in Queensland, then Victoria (20%, 70) and NSW (18%, 62). This likely reflects the maturity and activity of the tiny house groups, State population, and the location of the Facebook groups where the survey was posted.

The comments highlighted the aspect of location (particularly given that the first survey found that the biggest drawback to tiny houses was 'nowhere to put them').

> *Close to public transport and local services including clinics. Nothing outside of major cities where jobs and services are available* (Male, 30-39)

The location aspect was linked to barriers, particularly LGA planning schemes; but

it also reflected libertarian tendencies of the tiny house movement as well as the bureaucratic, inconsistent and complex nature of Australian planning.

> *Needs to be more focus on where we can build without having people complain or having gov step in to say this can't happen..,in Australia where we have great amounts of land we are blocked by different levels of gov particularly at council level.* (Female, 50-59)

Interestingly, one respondent mentioned that the location was dependent on the impacts of future climate change.

> *I have been researching severe climate events in different locations and would want a sound dwelling (eg cyclone certified) in a relatively climate-protected location. (*Female, 60+)

Others expressed a more cynical view of LGAs, developers and planning in general.

> *Skirting the law is the Australian way, after all. …I prefer the current situation, as big developers have to obey those rules but self-builders can largely ignore them thanks to complaint-based enforcement (*Male, 40-49)

Demographically, ages ranged from under 18 (1) to over 60, with the majority being 50-59 (33%) and over 68% were over 40. Two thirds were female (67%), and of these, 52 (n=114) were over 40. A smaller number were aged 18-29 and from 30-39: likely because they are employed full time and/or raising children. A crosstabulation chi-square analysis was performed and a significant relationship was found between gender and age: X2 (18, N = 369) = 362.58, p =.001. A similar analysis found a significant relationship between gender and building the tiny house; with females more inclined to use a tiny house builder and males more likely to DIY, X2 (24, N = 369) = 72.319, p =.001.

Drivers of tiny houses

The drivers for tiny house living (see Figure 2) were primarily economic, environmental and social. The social indicators were ranked higher than in the previous survey, with high importance given to living off grid, survivalism, and protecting against economic crashes. This is likely due to the geopolitics at the time (November 2017) s, such as the Trump administration in the USA and the potential conflict with North Korea.

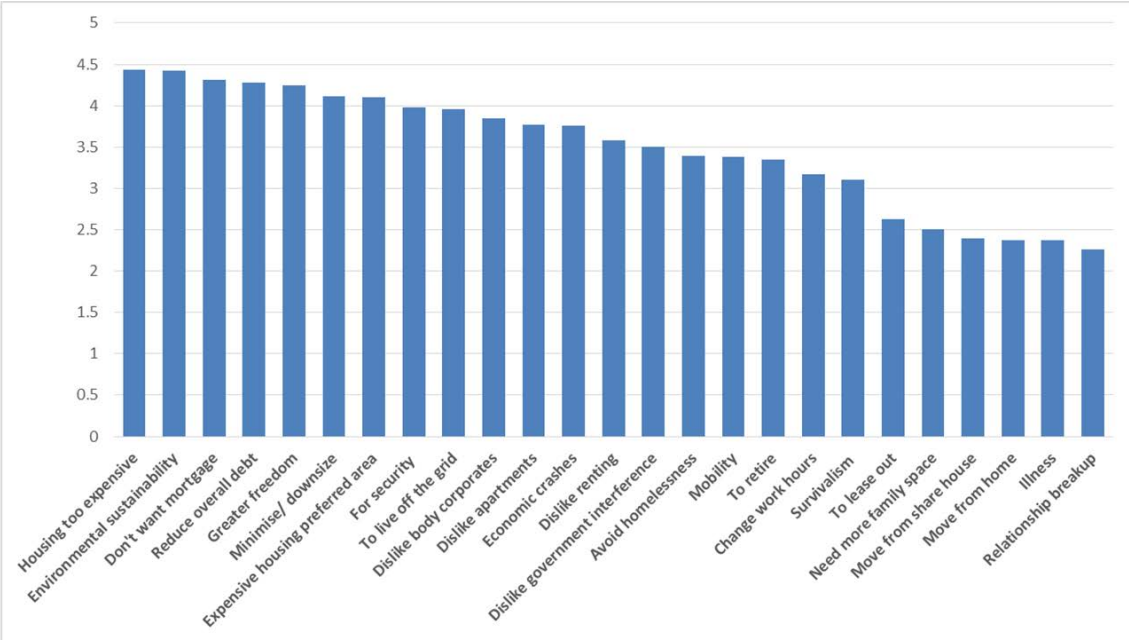


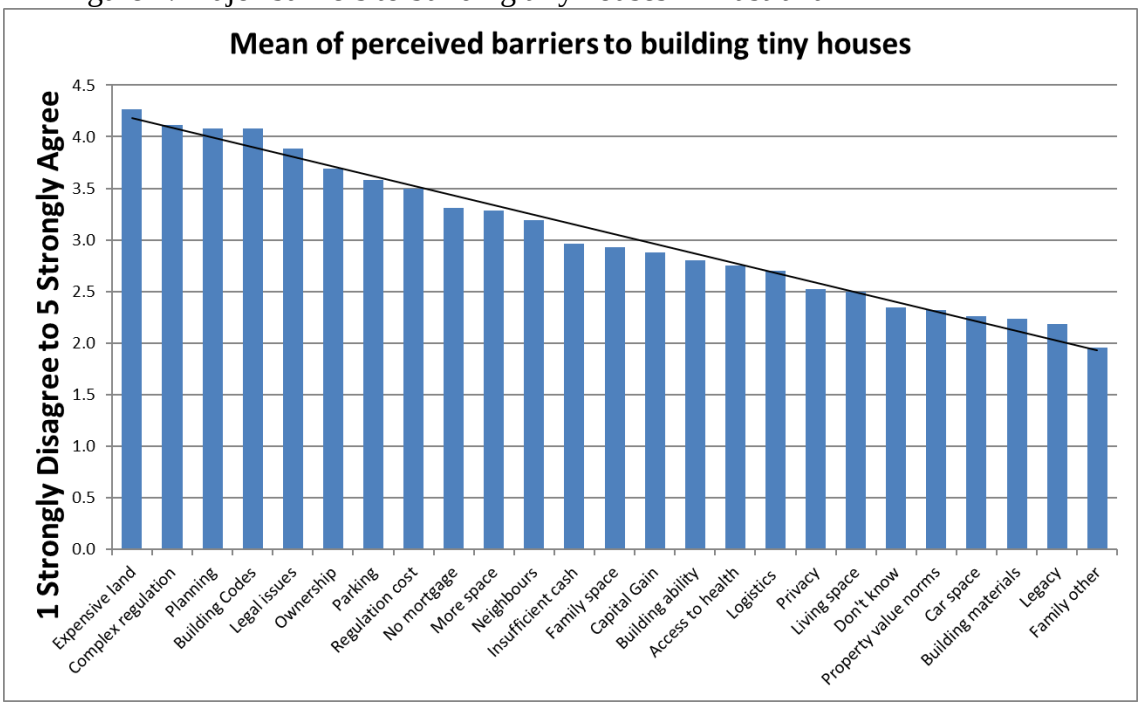
Figure 2: Drivers of Tiny Houses (mean score 5-point Likert Scale, strongly agree to strongly disagree).

> *I support the ideas of tiny houses for conscious consuming. We all consume too much land. Infrastructure and space for what we need. We then choose to fill up the spaces with more stuff and also travel further to our destinations using more fuel to get there. It's a downward spiral which could be contained by more sensible accommodation choices and a more thoughtful attitude towards resources.* (Female, 40-49).

Barriers to tiny houses

The study also asked, in 5 point Likert Scale about the perceived barriers to building a tiny house (see Figure 4). Broadly speaking, the barriers were not ranked as highly as the drivers, with only two having mean scores over 4, both related to planning. Planning schemes, building codes, the legality of tiny houses and nowhere to park the tiny house (ranked 1 in the previous study, now ranked 7) were the major perceived barriers to building a tiny house. Other economic barriers were noted, and included lack of cash, inability to get mortgages and the cost of building permits. The remaining barriers were social, and included neighbour complaints, lack of building ability and too small.

Figure 4. Major barriers to building tiny houses in Australia



> *Building codes and legislation that is complex, contradictory and outdated is the real problem. Almost everyone could benefit from a tiny house - either to get started, suited for …lifestyle or circumstances, for extended or growing family, investment or holiday retreat in remote off grid.* (Male, 30-39)

WHERE TO NOW FOR TINY HOUSES?

This study found that the tiny house movement has significantly increased in popularity in the past 2 years, with a tenfold increase in tiny house groups, and a doubling of members in the original groups. Greater numbers (although still very low) of people had built their own tiny house. This is likely due to the continued increase in house prices, as well as the popularity of the downsizing movement (linked to a general increase in environmental concern), and the slight easing of planning scheme restrictions.

The drivers behind the tiny house movement are predominantly economic and relate to the cheaper cost of tiny houses, expensive land, desire to cut work hours, and reduce or eliminate debt. Environmental drivers are also important, the desire to live off grid, reduce ecological footprint, to minimise possessions and practice conscious consuming.

Barriers were not ranked as highly as drivers, were largely related to planning restrictions; and were ranked lower than in 2015 (Shearer, 2015b, Shearer, 2015a). Fewer highlighted a lack of information, building ability or access to building materials.

A variety of tiny house groups are sharing information, online and in person through meetups etc., and that innovators and early adopters have motivated more 'mainstream' people. Tiny houses particularly appeal to single, older women, a demographic at increasing risk of homelessness, due to insufficient superannuation, marital breakup and long term rental status (Petersen and Parsell, 2015). THoWs could enable older women to live in a separate house on property belonging to family members, and help with care of grandchildren etc. which would have major social and economic benefits.

Tiny houses are no panacea for the wicked problems of housing unaffordability and

unsustainable development, but could be a valuable component in a toolbox of housing options for urban areas. Tiny houses can be economically, environmentally and socially sustainable; they combine green building principles with affordability, and would be relatively simple to slot into current urban physical and legal infrastructure. Contemporary urban areas are largely path dependent, and densification options often result in objections from current residents. Tiny houses are attractive and well built, and can be included into current suburban infrastructure relatively simply.

Australian capital cities are characterised by large old houses on large lots, and small, ageing households. Many are unwilling to sell, given the lack of smaller affordable housing in the same area. Promoting tiny houses could enable densification of these suburbs without the vertical sprawl of inner city high rise development, potentially freeing up the larger houses for new families, with the owner moving to the tiny house and getting rental income from the larger house (anecdotally, this is already occurring in many Australian cities). This would add to the rental stock, allow families to move closer to the city, and facilitate shared living, community and intergenerational mixing.

Moreover, the environmental value of tiny houses cannot be overstated; population growth and urbanisation is putting increasing pressure on scarce resources. Housing is a significant source of GHG emissions, land clearing and other impacts. Reducing construction materials and waste, as well as energy and water use will have a long term positive benefit for the environment. Mobile tiny houses can even be moved in case of extreme weather events, such as cyclones, floods or bushfire; and as temporary dwellings, do not necessitate major infrastructure upgrades.

> *Tiny housing offers a major disruptive solution to an ever growing affordability and social divide in housing.* (Female, 40-49)

This study scratches the surface of a yet unexplored area, and much further research is needed in this space. The study shows however, that tiny houses have the potential to be part of the mix of urban built infrastructure, as environmentally and economically sustainable housing forms. Building tiny houses can also add to employment and training.

Tiny houses appeal to many demographics; especially older, single women, the ‘Millennium’ generation, the ‘creative class’ of inner city dwellers and those who, in response to contemporary capitalist culture, tend to be anti-establishment and minimalist (Anson, 2014, Florida, 2000). Perhaps the true significance of tiny houses lies in that disruptive value, and their ability to precipitate a paradigm shift in social norms, to encourage awareness of the waste of resources in modern construction (Kilman, 2016). The emphasis on quality, community, sustainability and minimalism is the philosophical antithesis of the McMansions and shopping malls (Ford and Gomez-Lanier, 2017). Research into the tiny house movement is still in its infancy, and future studies, by this author and others, will no doubt build on the information in this and other articles.

REFERENCES

.IDCOMMUNITY. 2017. *Dwelling type: Greater Brisbane* [Online]. Available: http://profile.id.com.au/australia/dwellings?WebID=270 [Accessed].

ABS 2017. 2071.0 - Census of Population and Housing: Reflecting Australia - Stories from the Census, 2016.

ANGLICARE AUSTRALIA 2017. Rental Affordability Snapshot. Anglicare Australia.

ANSON, A. 2014. "the World Is My Backyard": Romanticization, Thoreauvian Rhetoric, and Constructive Confrontation in the Tiny House Movement. *From Sustainable to Resilient Cities: Global Concerns and Urban Efforts,* 14**,** 289-313.

BARES, V., PIETERS, R., NOBEL, L., WINKLE, B., MEATHREL, K., SHEARER, H. & CANIGLIA, F. 2017. A Place for Tiny Houses. Exploring the possibilities: Tiny House Planning Resource for Australia, 2017.

BDDRC 2016. Decision Appeal no 39-16. *In:* COMMITTEES, B. A. D. D. R. (ed.).

CARLIN, T. M. 2014a. Tiny homes: Improving carbon footprint and the American lifestyle on a large scale. *Celebrating Scholarship and Creativity Day.* .

CARLIN, T. M. 2014b. Tiny homes: Improving carbon footprint and the American lifestyle on a large scale.

CEDA 2017. Housing Australia. Committee for Economic Development of Australia.

COX, W. & PAVLETICH, H. 2009. 6th annual Demographia international housing affordability survey. *Retrieved March,* 3**,** 2009.

COX, W. & PAVLETICH, H. 2015. International Housing Affordability Survey. *Demographia (www. demographia. com).*

DEMOGRAPHIA 2017. Demographia, World Urban Areas, 13th Annual Edition: 2017:04.

DIGUETTE, R. 2017. Lessons from the first 'tiny house' evangelist, Henry David Thoreau. *Washington Post*.

DODSON, J. & SIPE, N. 2008. Shocking the suburbs: urban location, homeownership and oil vulnerability in the Australian city. *Housing Studies,* 23**,** 377-401.

ESC CONSULTING. 2016. *Landmark precedent for the Tiny House on Wheels* [Online]. Available: https://escconsulting.com.au/2016/11/18/landmark-precedent-for-the-tiny-house-on-wheels/ [Accessed].

ESC CONSULTING. 2017. *Tiny House Deep Dive* [Online]. Available: https://escconsulting.com.au/2017/10/11/tiny-house-deep-dive/ [Accessed].

FLORIDA, R. 2000. Competing in the age of talent: Quality of place and the New Economy (Report to the RK Mellon Foundation, Heinz Endowments and Sustainable Pittsburgh). Pittsburgh. PA: Carnegie Mellon University.

FORD, J. & GOMEZ-LANIER, L. 2017. Are Tiny Homes Here to Stay? A Review of Literature on the Tiny House Movement. *Family and Consumer Sciences Research Journal,* 45**,** 394-405.

GOOGLE TRENDS. 2017. *Google Trend Search: Tiny Houses* [Online]. Available: https://www.google.com/trends/explore#q=tiny%20houses [Accessed].

HUNN, P. 2017. Australian cities among the largest and least densely settled in the world. *ArchitectureAU,* 20 April 2017.

ICC 2017. Overview of the International Residential Code® (IRC®). International Code Council.

JONES, C. M. & KAMMEN, D. M. 2011. Quantifying carbon footprint reduction opportunities for US households and communities. *Environmental science & technology,* 45**,** 4088-4095.

KILMAN, C. 2016. Small House, Big Impact: The Effect of Tiny Houses on Community and Environment. *Undergraduate Journal of Humanistic Studies,* 2.

MBQLD nd. Building Code of Australia. *In:* QUEENSLAND, M. B. (ed.).

MITCHELL, R. 2014. *Tiny House Living: Ideas for Building and Living Well in Less Than 400 Square Feet,* " F+ W Media, Inc.".

MUTTER, A. 2013. *Growing Tiny Houses Motivations and Opportunities for Expansion Through Niche Markets.*

NONKO, E. 2016. Tiny house zoning regulations: What you need to know. *Curbed.*

PAWSON, H., HULSE, K. & CHESHIRE, L. 2015a. Addressing concentrations of disadvantage in urban Australia.

PAWSON, H., RANDOLPH, B., YATES, J., DARCY, M., GURRAN, N., PHIPPS, P. & MILLIGAN, V. 2015b. Tackling housing unaffordability: a 10-point national plan *The Conversation.*

PETERSEN, M. & PARSELL, C. 2015. Homeless for the first time in later life: an Australian study. *Housing Studies,* 30**,** 368-391.

PULLEN, S., HOLLOWAY, D., RANDOLPH, B. & TROY, P. Energy profiles of selected residential developments in Sydney with special reference to embodied energy. Proceedings of the Australian & New Zealand Architectural Science Association (ANZAScA) 40th Annual Conference, 2006. 22-25.

SENATE ECONOMICS REFERENCE COMMITTEE 2015. Out of reach? The Australian housing affordability challenge.

SHEARER, H. 2015a. The 'tiny house' movement: its implications for housing affordability and urban sustainability. *In:* HOUSING AND COMMUNITY RESEARCH UNIT, U. O. T. (ed.) *Australian Housing Researchers Conference.* Hobart, Tasmania.

SHEARER, H. Tiny houses: a radical new solution for addressing urban housing affordability, or a just another niche market? *In:* BURTON, P. & SHEARER, H., eds. State of Australian Cities Conference 2015, November 2015 2015b.

SHEARER, H. 2017. Interest in tiny houses is growing, so who wants them and why? *The Conversation.*

SHEARER, H., COIACETTO, E., DODSON, J. & TAYGFELD, P. 2016. How the structure of the Australian housing development industry influences climate change adaptation. *Housing Studies,* 31**,** 809-828.

THA. 2017. *Tiny Houses Australia Facebook Group* [Online]. Available: https://www.facebook.com/groups/TinyHousesAustralia/ [Accessed].

THOREAU, H. D. 1854. *Walden,* Yale University Press.

TINY HOUSE BUILD 2014. Why tiny houses can save the earth.

TINY HOUSES AUSTRALIA. 2017. *Tiny Houses Australia Facebook Group* [Online]. Available: https://www.facebook.com/groups/TinyHousesAustralia/ [Accessed].

WENTZ, E. A. & GOBER, P. 2007. Determinants of small-area water consumption for the city of Phoenix, Arizona. *Water Resources Management,* 21**,** 1849-1863.

WIKIPEDIA. 2017. *Earthship* [Online]. Available: https://en.wikipedia.org/wiki/Earthship [Accessed].

WILSON, A. & BOEHLAND, J. 2005. Small is beautiful - US house size, resource use, and the environment. *Journal of Industrial Ecology,* 9**,** 277-287.

WORTHINGTON, A. 2011. The quarter century record on housing affordability, affordability drivers, and government policy responses in Australia.

YATES, J. 2008. Policy Forum: Housing Affordability: What Are the Policy Issues? Australia's Housing Affordability Crisis. *The Australian Economic Review,* 41**,** 200-214.

YATES, J. & GABRIEL, M. 2006. Housing affordability in Australia.

YATES, J., RANDOLPH, B. & HOLLOWAY, D. 2006. Housing Affordability, Occupation and Location in Australian Cities and Regions - Final Report. *In:* INSTITUTE), A. A. H. A. U. R. (ed.).

MOST NEW HOUSING IS NOT HIGH-END HOUSING[1]

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Abstract
This paper analyses the spatial distribution of new housing supply in Australia. We find that most new houses have been built in areas with below-average prices, while most new apartments and townhouses have been built in Sydney and Melbourne, where median prices are higher. Our analysis extends recent Australian research by Ong et al (2017), who conclude that housing supply is concentrated in areas with relatively high prices. Their main finding fails to account for the different populations of local government areas in their approach, resulting in misleading conclusions. This paper updates this earlier research to account for the different sizes of LGAs.

Key words: Housing supply; housing stock; housing affordability; filtering; local government areas; housing affordability.

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INTRODUCTION

Australian housing is becoming increasingly expensive. Australian house prices have more than doubled in real terms since the mid-1990s, far outstripping growth in household incomes. Australian spending on housing has increased from about 10 per cent of total pre-tax household income in 1980 to about 14 per cent today (Daley et al., 2018). Low-income earners' spending on housing as a share of income has increased much more than other households over the past decade. Quality-adjusted rents have grown more slowly than house prices. However, low-income households, particularly those living in capital cities, are spending a greater share of their income on rent, and as a result, more are financially stressed.

Several Australian government, academic and private-sector studies have pointed to slow housing supply, and restrictive zoning in particular, as an important factor in Australia's high and rising housing prices ((Kendall and Tulip, 2018); (Kulish et al., 2011); (Productivity Commission, 2017); (Productivity Commission, 2011); (OECD, 2010)). A large and growing international literature consistently highlights how land use planning rules have reduced the ability of many housing markets to respond to growing demand, pushing up house prices in major cities in a number of countries ((Glaeser and Gyourko, 2018); (Hilber and Vermeulen, 2015); (Lees, 2017)). Most of those papers that make policy recommendations call for increases in land supply and changes to zoning rules to allow for greater housing density. Our recent report, *Housing affordability: re-imagining the Australian Dream,* makes similar recommendations.

Yet a number of Australian housing researchers are sceptical that increasing housing supply will improve affordability. They argue that most new housing built in Australia is too expensive for low- and middle-income earners. They assert that building more homes won't lower the rents paid by the poorest Australians unless those homes are explicitly built to house them.

In particular, recent research by (Ong et al., 2017) 'Spatial and Temporal Patterns in Housing Supply: A Descriptive Analysis' (hereafter Ong et al) finds that most of the growth in housing supply is concentrated in areas with relatively high prices. They compare the number of new building approvals across price deciles of unweighted Local Government Areas (LGAs). The authors conclude that "housing supply is doing little to directly expand affordable housing opportunities in those price ranges within the reach of low income households" (p.13).

But this conclusion is misleading. Ong et al erroneously create price deciles with an equal number of LGAs, rather than weighting by the number of dwellings (or population) within each LGA. But LGAs are of vastly different populations, so the finding that most new housing is built in expensive LGAs purely reflects that these LGAs are the most populated. Half of all Australians live in the 10 per cent of LGAs with the largest populations — all of which are in or close to our major cities. Just 5 per cent of Australians live in the smallest half of all LGAs.

And claims that more housing doesn't help low-income earners are at odds with international literature showing that market-rent housing remains the largest source of affordable housing for low-income earners.

This debate matters, because affordable housing advocates are using this research to argue that boosting the supply of market-rate housing won't make housing more affordable, and that governments should focus on increasing the subsidies for affordable housing rather than tackling politically difficult planning reforms (for example (Gurran et al., 2018)).

More housing supply isn't the only solution to make housing more affordable for low-income earners. Reforms to reduce demand for housing will make housing more

somewhat affordable, but alone are unlikely to solve the problem. More social and affordable housing is needed to help those struggling with high housing costs, but the required subsidies are very large, and even at its peak only housed one third of the poorest 20 per cent of Australians (Daley et al., 2018). Making housing cheaper overall will reduce the amount of public subsidy needed to bridge the gap between the market price of housing and what low-income earners can afford to pay. But more importantly, it would make housing more affordable for the bulk of low-income earners not in social and affordable housing.

This paper is structured as follows. First, we examine the approach of Ong et al (2017). Second, we undertake our own analysis of the spatial distribution of new housing supply. Our new analysis, which accounts for the different sizes of LGAs, shows that two-thirds of new houses have been built in the cheapest half of all LGAs, while most new units and apartments have been built in Sydney and Melbourne, where median prices are higher. We then review the literature on 'filtering' of market-rate housing, and find that international evidence points to market-rent housing being an important source of affordable housing for low-income earners, which supports our view that increasing the supply of housing will improve housing affordability overall, including for many low-income earners.

PAST RESEARCH ON THE SPATIAL DISTRIBUTION OF NEW HOUSING IN AUSTRALIA

(Ong et al., 2017) seek to answer two main questions in the section of their paper analysing the distribution of new housing: 1) whether new housing supply is concentrated in high-price or low-price market segments, and 2) whether or not new houses and units are being built in areas where labour market opportunities are concentrated. Ong et al analyse Australian housing supply in two financial years: 2005-06 and 2015-16.

This section will explain the approach used by Ong et al to analyse new housing supply in Australia, summarise their key results, and explain the methodological issues which cause the paper's key findings to be misleading. While our technical critiques apply to both topic areas of the Ong et al paper, we will focus on their analysis of the geographical distribution of new housing supply – not job opportunities.

Ong et al analyse the distribution of new housing supply for houses and units across all LGAs in 2005-06 and 2015-16.[2]

The authors rank all LGAs according to the median prices of houses and units, from lowest to highest, for 2005-06 and 2015-16.[3] They then divide the ranked LGAs into ten deciles, each containing the same number of LGAs. As a proxy for housing supply, the authors use the number of building approvals in each LGA.[4] They then count the number of building approvals within each LGA in each of these deciles. Figure 1 presents the results of this analysis (from Table 1 in Ong et al).

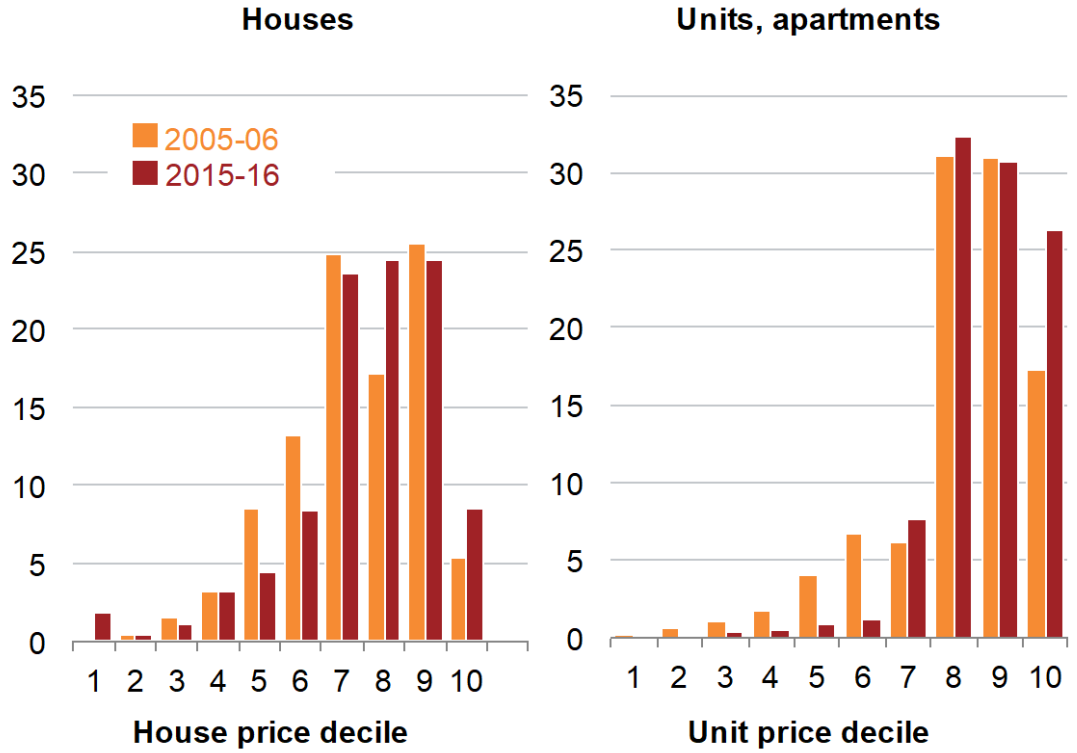
[2] In Ong et al's analysis, 'houses' comprise separate houses, semi-detached, row or terrace houses, and 'units' comprise flats, units or apartments.

[3] Data for median house and unit prices in each LGA comes from CoreLogic.

[4] From Australian Bureau of Statistics Cat. No. 8731.0 *Building Approvals, Australia*. Ong et al acknowledge that not all building approvals are converted into housing completions that actually impact on the housing supply. However they present international research which shows a high correlation between housing approvals and building commencements – suggesting that approvals are a good proxy for new housing supply HWANG, M. & QUIGLEY, J. 2006. Economic Fundamentals in Local Housing Markets: Evidence from U.S. Metropolitan Regions. *Journal of Regional Science,* 46**,** 425-453.

Figure 1: Ong et al claim that most new homes are targeted at the top end of the market

Share of new housing and unit approvals (per cent) in 2005-06 and 2015-16 in each LGA, ranked by their median house and unit price deciles



Note: Price deciles are calculated on median house and unit prices in each LGA across Australia, unweighted for population size of LGAs.
Source: Ong et al (2017) Spatial and Temporal Patterns in Housing Supply: A Descriptive Analysis, Table 1.

The authors find that in both 2005-06 and 2015-16, most new housing was built in LGAs in the top five price deciles. In 2005-06 more than 86 per cent of house approvals and 92 per cent of unit approvals were built in the most expensive half of all LGAs. By contrast less than 1 per cent of house approvals and around 2 per cent of unit approvals were built in the bottom two price deciles. In 2015-16 the share of new house and unit approvals in the top five deciles increased to around 89 per cent and 98 per cent respectively.

Based on these findings, Ong et al conclude that most new housing has been built in more expensive areas, and that this trend became more pronounced over time.

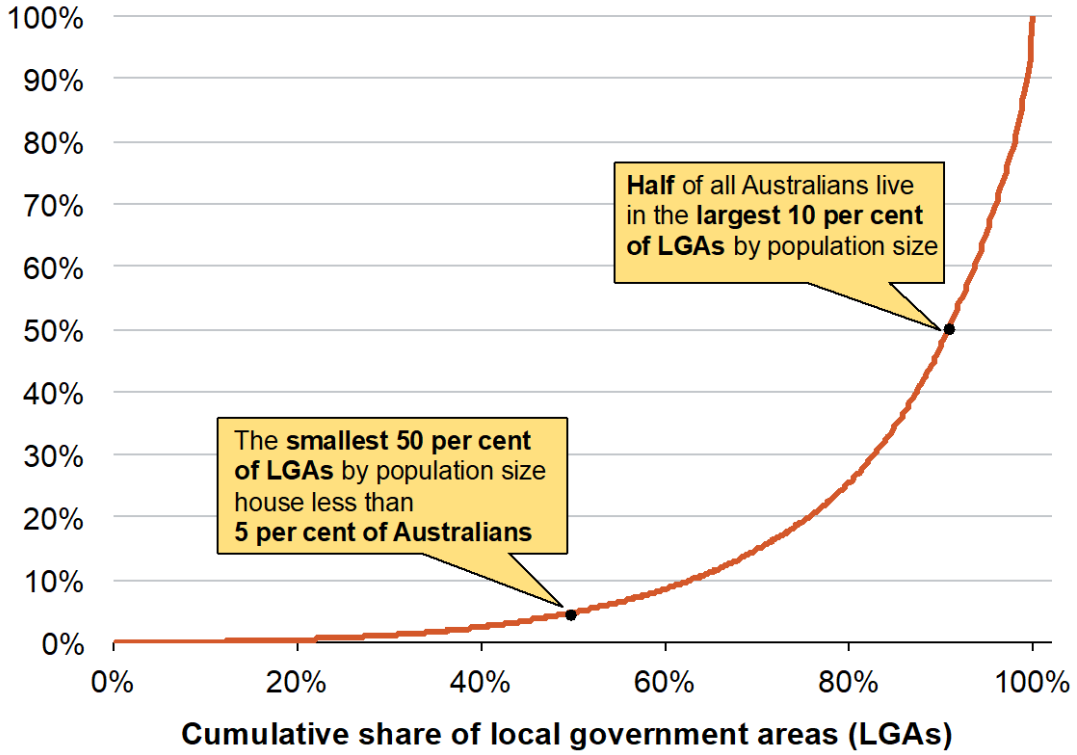
While compelling on face value, Ong et al's main conclusion is flawed because the authors fail to weight the price deciles by the number of existing dwellings in each LGA. While they do consider approvals as a share of the existing unit and house stock within each decile, this is not necessarily representative of the population within an LGA, nor is it given much emphasis in their conclusion.

Not weighting the price deciles by the existing dwelling stock is significant because LGAs have very different populations, ranging from 62 people in Maralinga Tjarutja in far-west South Australia to 1,184,215 in the Brisbane City Council ((ABS, 2016).) Brisbane has 459,227 houses and units, while Maralinga Tjarutja has only 14.

Figure 2 shows that the cumulative population distribution across LGAs is exponential. While just 5 per cent of Australians live in the smallest half of all LGAs, half of all Australians live in the 10 per cent of LGAs with the largest populations — all of

which are in or close to our major cities (ABS, 2017b). Most LGAs with small populations are in rural and regional areas. With relatively few jobs being created there, these aren't the places where we would expect much new housing (ABS, 2017c).

Figure 2: Most Australians live in only a few LGAs, concentrated in our largest cities
Cumulative share of Australian population by LGAs, 2016

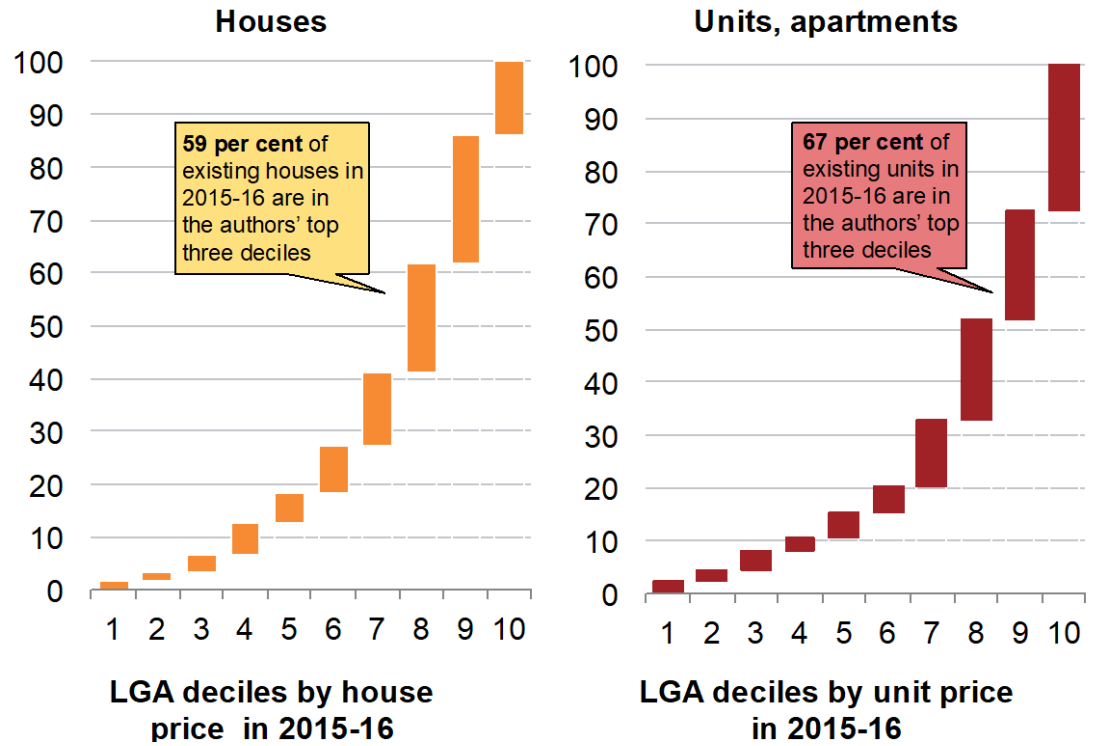


Note: LGAs are ranked by population size from smallest to largest.
Sources: ABS 3218.0 Regional Population Growth, Australia, 2015-16; Author analysis.

Figure 3 shows that in Ong et al's analysis, LGAs in the bottom six house price deciles contained just 27 per cent of all houses in 2015–16. By contrast, the LGAs in the top three house price deciles account for 59 per cent of the existing housing stock. The distribution of units across LGAs is more uneven than for houses. The top three unit price deciles account for 67 per cent of the unit stock in 2015-16.

Figure 3: Ong et al fail to weight their deciles by dwellings or population when sorting LGAs by price

Cumulative share of existing homes (per cent) in each LGA, 2015-16, by LGA deciles



Note: House price deciles are calculated on median house and unit prices in each LGA across Australia, unweighted for population size of LGAs.

Source: Ong et al (2017) Spatial and Temporal Patterns in Housing Supply: A Descriptive Analysis.

It is hardly surprising that most new housing is built in the highest price deciles — they already house most of the population and contain most of the housing stock. These LGAs represent the vast bulk of Australia's major cities, where population and jobs are growing faster than regional areas (Daley, 2016, Daley et al., 2017, Infrastructure Australia, 2018).

The skew in the analysis introduces significant distortions. A suburb with the same median house price as Australia overall ($608,000 for the capital cities in July 2015 (CoreLogic, 2015)) would not fall in the authors' middle LGA decile, as might be expected, but would instead fall in the second-highest price decile. The Australia-wide capital city median unit price, $505,000, would sit in the authors' second-highest unit price decile.[5] In fact, no Australian capital city has a median house price within the bottom half of Ong et al's house price deciles in 2015-16. And only Hobart has a median unit price that falls in the bottom half of LGAs by median unit price (in the fifth decile) (CoreLogic, 2015).

Overall, Ong et al's price deciles are highly unrepresentative of the distribution of housing in Australia, which leads to flawed conclusions about the distribution of new housing supply. By not weighting price deciles by the existing population or the existing dwelling stock, it is misleading for Ong et al to conclude that "new housing opportunities are increasingly tilted toward the more expensive end of the housing market".

[5] According to the Domain Report (December 2015): median house price: $723,163, median unit price: $517,575

WEIGHTING PRICE DECILES BY THE EXISTING DWELLING STOCK

In this section, we improve on Ong et al's analysis by weighting price deciles by the existing dwelling stock. We examine new housing supply in 2005-06 and 2016-17 (due to access to newer data we analyse new housing supply in 2016-17 rather than 2015-16). In addition to examining new housing supply on a national basis, we also present results for New South Wales and Victoria, Australia's two largest states.

We use the following data sources in our analysis:

- We follow the approach of Ong et al in using the number of building approvals as a proxy for housing supply. This is obtained from ABS Building Approvals data for both 2005-06 and 2016-17 (ABS, 2018b).[6]
- The dwelling stock within each LGA is obtained from the 2006 Census and the 2016 Census.
- Median house and unit price data by LGA is from CoreLogic.

We use a different definition of 'houses' and 'units' to Ong et al.

Ong et al define 'houses' as comprising separate houses, semi-detached, row, and terrace houses, and townhouses. They define 'units' as comprising flats, units, and apartments. We define units as all non-detached dwellings, which in addition to flats, units, and apartments includes semi-detached, row, and terrace houses, and townhouses. Our definition aligns with the definition of 'houses' and 'other residential' dwellings used by the ABS ((ABS, 2018a); (ABS, 2017a)).[7]

In 2016, separate houses made up 71 per cent of all private dwellings (ABS, 2016). Flats and apartments accounted for 14 per cent of all private dwellings, and semi-detached, row, terrace, and townhouses made up 12 per cent of all private dwellings.

We make some adjustments to our data to match up the ABS Census and building approvals data and the CoreLogic dwelling price data. For the 2005-06 analysis, adjustments are needed to account for changes to LGA boundaries made by the Queensland Government in 2008 (Queensland Government, 2010). The Census and building approvals data use the LGAs prior to the 2008 amalgamations, whereas the CoreLogic price data had LGAs as they were after the 2008 LGA amalgamations. The 2006 LGA structure is kept, with median prices of the larger post-2008 amalgamated LGAs assigned to the smaller LGAs that were amalgamated. For example, the Blackall-Tambo LGA was created from the merger of the Blackall and Tambo councils. The CoreLogic median house and unit price data for the Blackall-Tambo LGA is assigned to the separate councils Blackall and Tambo that existed before 2008.

For the 2016-17 analysis, adjustments are needed to account for the NSW Government's 2016 changes to LGA boundaries. The CoreLogic data uses LGA boundaries as they were before the LGA amalgamations. To match how these LGAs were recorded in the 2016 Census, which used the post-amalgamation LGA boundaries, the median unit and house prices of LGAs that were amalgamated were averaged. For example, the new LGA of Central Coast was formed from the merger of Gosford and Wyong LGAs. The average of the median prices for Gosford and Wyong is used as the median price for the Central Coast LGA.

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[6] For 2005-06, approvals in each Statistical Local Area (SLA) were converted to approvals by LGA using ABS Concordances (ABS 2005. 1216.0.15.002 - Australian Standard Geographical Classification (ASGC) Concordances, 2005 Australian Bureau of Statistics.). For example, in 2005-06, the Ballarat LGA was composed of four separate SLAs: Ballarat - Central, Ballarat - Inner North, Ballarat - North, and Ballarat - South.

[7] Our approach is also consistent with the definitions of houses and units used by CoreLogic in their price data.

CoreLogic does nothave house or unit price for some regional LGAs (for example Bland (NSW) and Golden Plains (Victoria) in 2005-06 and Bourke (NSW) and Carpentaria (QLD) in 2016-17). Where there is no price data available, these LGAs were excluded from the analysis. Exclusions were more common when analysing the supply of units, as fewer regional LGAs had unit price data (as there was likely none or few unit sales in these regional areas). Since these LGAs also tend to have lower dwelling prices than average, excluding them from the analysis adds an upwards bias to our calculation of the new housing supply distribution. However, this effect is small given these LGAs' generally small dwelling stock had few building approvals.[8]

We then calculate the distribution of house and unit approvals in 2005-06 and 2016-17. Importantly, unlike Ong et al, we calculate *weighted* price deciles for each LGA for houses and units, using the total dwelling stock within each LGA as the weights. Weighting price deciles by the population of LGAs would produce very similar results. LGAs without price data for a particular year were excluded. The result from weighing price deciles is that each decile for houses and units contains approximately the same number of dwellings (see Table 1). The weighted price deciles don't contain exactly 10 per cent of the dwelling stock because each LGA has to be allocated to one decile. For example, for houses in 2005-06, the share of the dwelling stock in each weighted price decile varies between 9.4 per cent and 10.8 per cent (Table 1). As explained earlier, some LGAs are much larger than others. Hence, when grouping together deciles it is impossible to attain a perfectly even distribution.

To find the housing supply in each weighted price decile, we sum the total number of the house and unit approvals from each LGA within each decile. The percentage of approvals within each weighted price decile is then calculated, along with the price bands for each decile (Table 1). We perform this analysis for Australia as a whole, for NSW, and for Victoria (with the weighted price deciles re-calculated each time).

A limitation of our approach, and earlier work by Ong et al, is that we can't observe whether new houses and units are cheaper, or more expensive, than existing types of each home in each LGA. On the one hand, new homes should be more expensive than the average for an LGA since they are new and have therefore not depreciated.

Table 1: House and unit approvals by weighted price decile in Australia

Houses	**2005-06**			**2016-17**		
- Weighted price decile	**Price band ($)**	**% of dwelling stock**	**% of approvals**	**Price band ($)**	**% of dwelling stock**	**% of approvals**
1	22,191 - 248,272	9.9	9.5	42,333 - 279,833	9.8	5.4
2	249,896 - 303,445	10.0	14.5	279,870 - 342,417	10.1	11.1
3	304,315 - 333,085	9.7	19.9	342,750 - 404,292	9.9	11.3
4	333,194 - 383,950	10.3	17.3	404,917 - 468,979	10.1	21.8
5	388,412 - 424,423	9.4	8.7	475,125 - 540,833	10.1	14.6

[8] Excluding smaller LGAs due to missing data would have a bigger effect on the distribution of housing approvals if deciles were not weighted, in the Ong et al analysis.

6	424,478 - 476,371	10.2	6.7	545,979 - 605,062	9.8	8.6
7	476,792 - 495,142	10.3	8.1	605,979 - 653,250	9.8	6.6
8	495,444 - 545,953	9.7	9.1	668,483 - 867,917	10.5	12.1
9	566,681 - 760,380	9.7	3.5	875,500 - 1,297,500	9.6	5.6
10	770,205 - 2,825,477	10.8	2.8	1,332,330 - 3,551,210	10.4	2.8

Units	2005-06			2016-17		
Weighted price decile	**Price band ($)**	**% of dwelling stock**	**% of approvals**	**Price band ($)**	**% of dwelling stock**	**% of approvals**
1	68,887 - 219,383	9.9	4.5	95,125 - 230,000	9.9	0.7
2	219,541 - 250,989	9.9	4.8	230,875 - 265,125	9.9	2.1
3	251,099 - 285,118	10.1	7.3	265,927 - 318,729	9.1	2.3
4	285,337 - 306,231	9.8	6.9	319,125 - 352,425	10.8	5.2
5	306,790 - 332,565	9.9	8.7	353,446 - 394,750	9.9	6.6
6	334,443 - 375,128	10.0	7.6	397,635 - 442,184	10.2	11.4
7	376,347 - 393,057	10.1	15.9	443,917 - 470,479	9.9	13.7
8	393,792 - 425,397	9.6	17.6	470,520 - 532,873	9.9	17.5
9	426,174 - 484,656	10.2	15.3	534,392 - 670,529	10.3	19.2
10	494,240 - 816,851	10.5	11.5	681,792 - 1,173,750	10.1	21.3

Note: price bands in $2016-17.
Sources: Author analysis based on CoreLogic data; ABS Census 2006 and 2016; ABS 8731.0 Building Approvals.

Yet new houses, and apartments in particular, are likely to be smaller than the existing stock, and therefore cheaper.

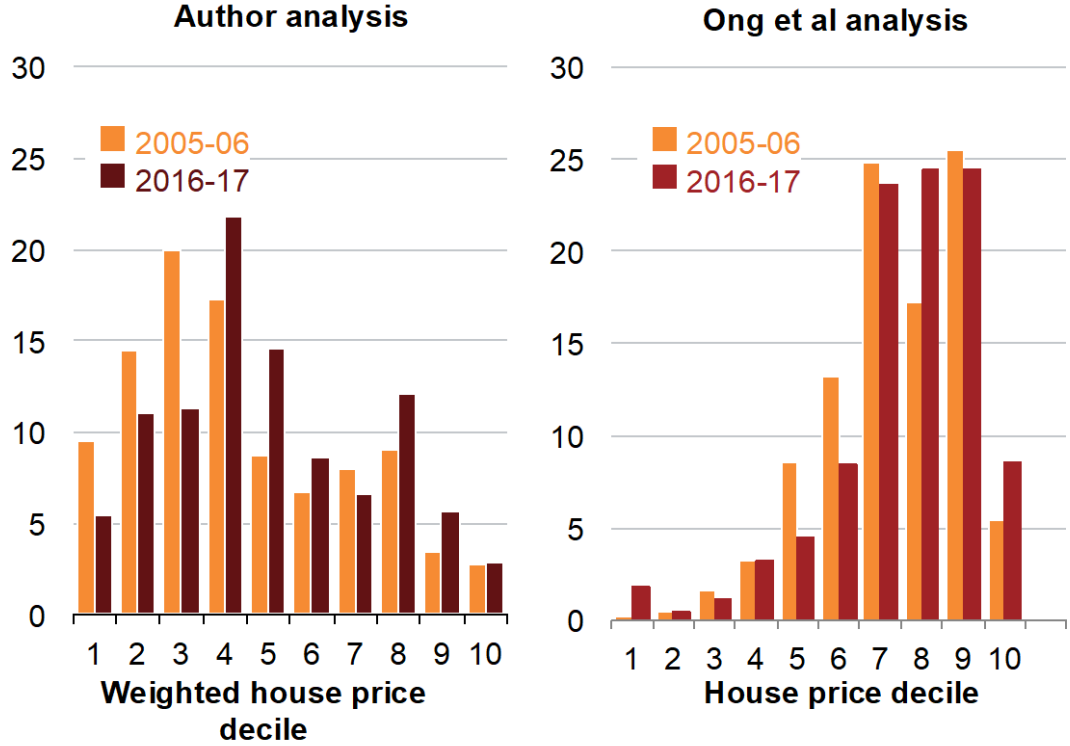
Another limitation of our analysis on the state level is that we find that the share of housing stock contained within each decile varies more than when doing the analysis for Australia. For example, for houses in Victoria in 2005-06, the share of the dwelling stock in each weighted price decile varies between 7.4 per cent and 11.9 per cent.

THE DISTRIBUTION OF NEW HOUSE APPROVALS

Our new analysis using weighted price deciles shows that most new homes have been built in cheaper suburbs, and not at the top end. This pattern holds on both a national level, and in each of NSW and Victoria.

Figure 4 compares our calculations of new house supply by weighted price deciles, and updated to 2016-17, compared to Ong et al's calculation of new house supply by unweighted price deciles.

Figure 4: Most new houses are actually being built in cheaper LGAs
Share of new house approvals (per cent), ranked by median house price deciles



Note: Price deciles are calculated on median house prices in each LGA across Australia.
Sources: Author analysis based on CoreLogic data; ABS Census 2006 and 2016; ABS 8731.0 Building Approvals; Ong et al (2017) Spatial and Temporal Patterns in Housing Supply: A Descriptive Analysis.

By using weighted price deciles, we draw much different conclusions about where new houses have been built. Our results show a distribution that is centred on the third, fourth, and fifth deciles. House approvals peaked at the third and fourth weighted house price deciles in 2005-06 and 2016-17 respectively. This is a noticeably different distribution to Ong et al, who find new house approvals concentrated in the higher price deciles. As explained earlier, this largely results from Ong et al using unweighted house price deciles, which results in the higher price deciles including a disproportionately large percentage of the housing stock.

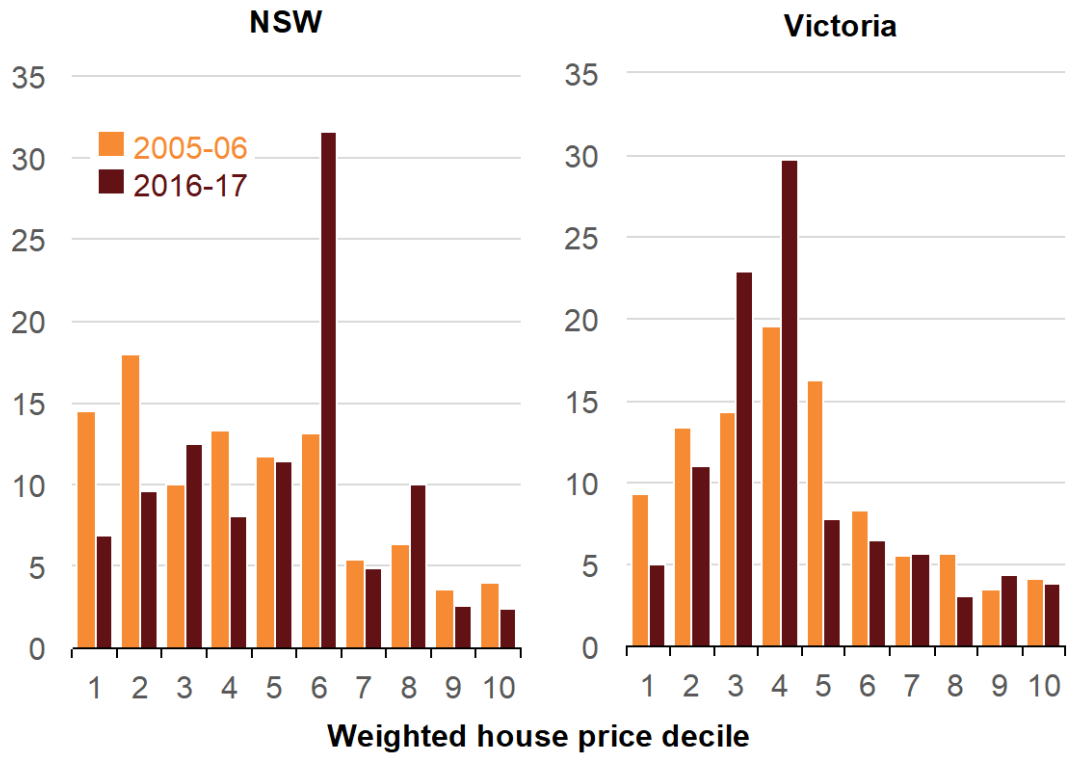
Whereas Ong et al claim that only 11 per cent of new houses in 2015-16 were built in the lower half of price deciles, we find that figure to be much higher in 2016-17, at 64 per cent. In 2016-17, almost half of the new houses were built in the third, fourth and fifth price deciles, where the median price range is from $342,750 to $540,833 (see Table). This is a typical price for a new house and land package in greenfield areas on the edges of our major cities (Realestate.com.au, 2018b, Realestate.com.au, 2018c, Realestate.com.au, 2018a), and includes LGAs such as Casey, Wyndham and Melton in Victoria, Moreton Bay and Redlands in Queensland, and Swan and Wanneroo in Western Australia.

And where Ong et al claim that only 2 per cent of new homes were built in the cheapest 20 per cent of LGAs in 2015-16, we find that 16 per cent of new houses in 2016-17 were in the cheapest LGAs.

Figure 5 shows the results of our analysis for NSW and Victoria. Compared to Australia, the supply of new housing in NSW has a flatter distribution, especially in the lower price deciles (the fifth decile has an upper bound price of $707,417).

Figure 5: Most new houses are being built in cheap and mid-priced LGAs in Sydney and Melbourne

Share of new house approvals (per cent) in 2005-06 and 2016-17, ranked by median house price deciles within each state



Note: Price deciles are calculated on median house prices in each LGA within each state.
Sources: Author analysis based on CoreLogic data; ABS Census 2006 and 2016; ABS 8731.0 Building Approvals.

The share of approvals in the more expensive LGAs increased between 2005-06 and 2016-17: the upper five deciles made up 32 per cent of housing supply in 2005-06, compared to 52 per cent in 2016-17. However, this was almost exclusively caused by an increase in the number of housing approvals in the sixth decile. The sixth price decile in 2016-17 has a price range of $709,083 to $814,375. Approvals in this decile mostly occurred in the Blacktown, Camden, and Liverpool LGAs. It is not surprising that new housing is being built in these outer-suburban LGAs. Planning rules and restrictions have made it easier to build new housing on city fringes, rather than in the inner and middle-ring suburbs (Daley et al., 2018).

Analysis of Victorian data also suggests a different conclusion to the one presented by Ong et al.

The distribution of Victorian housing supply largely resembles Australia as a whole. Most new supply in 2005-06 (72 per cent of new approvals) was concentrated in the lower five deciles. In 2016-17 the percentage of new houses built in cheaper LGAs increased slightly, to 76 per cent.

The biggest changes in Victoria were in the third and fourth deciles. From 2005-06 to 2016-17 the share of total house approvals in these two deciles increased from 34 per cent to 52 per cent. In these deciles, the LGAs with the most approvals were Wyndham, Greater Geelong, Casey, Hume and Melton, all on the edge of Greater Melbourne. Land in these greenfield areas has been substantially cheaper than comparable greenfield areas in Sydney. In 2016 greenfield land in Sydney sold for around $1,200 per square metre, compared to about $600 per square metre in Melbourne (UDIA, 2017). Slow land release and geographical constraints in Sydney contributed to this price difference (UDIA, 2017). Cheap land on Melbourne's fringe, relative to Sydney, has made Melbourne a destination for interstate and overseas migrants, which has contributed to strong population growth (Daley et al., 2018). From 2006 to 2016 the population of Wyndham increased by 98 per cent and the total housing stock increased by 84 per cent (ABS, 2017c, ABS, 2018b).

Our analysis using weighted price deciles shows that most new houses have been built in low- and mid-priced LGAs, not in high-priced LGAs as suggested by Ong et al's analysis. Between 2005-06 and 2016-17 the supply of new houses shifted slightly upwards into higher weighted price deciles.

THE DISTRIBUTION OF NEW UNIT APPROVALS

We now present the results of our national and state-level analysis of the spatial distribution of new units.[9]

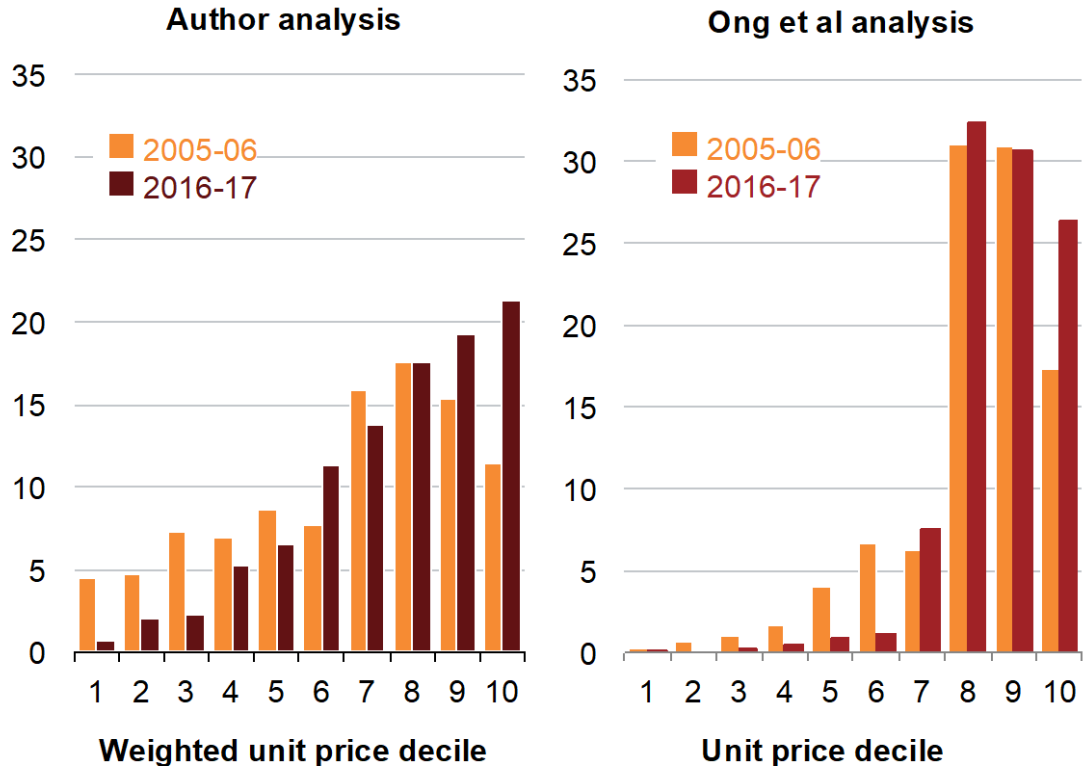
Units, apartments, semi-detached, row and terrace houses, and townhouses accounted for 49 per cent of all building approvals in 2016, up from 32 per cent in 2005. As Australian cities grow in size and land has become more expensive, Australians are increasingly favouring high- and medium-density housing over detached houses. Previous Grattan Institute research found that after accounting for trade-offs in price, location, and size, many people would prefer a townhouse, semi-detached dwelling, or apartment in a middle or outer suburb over a house on the city fringe (Daley et al., 2018, Kelly et al., 2011).

We find that units have largely been supplied in the LGAs that sit within high-weighted unit price deciles. But this pattern is not as stark as the results presented in Ong et al's paper. Figure 7 shows the differences between our analysis for Australia and the analysis in Ong et al.

[9] As described in the research methodology section, our definition of units includes units, apartments, semi-detached, row and terrace houses, and townhouses.

Figure 7: Most new units are being built in more expensive LGAs in Sydney and Melbourne

Share of new unit approvals (per cent), ranked by median unit price deciles



Notes: Price deciles are calculated on median unit prices in each LGA across Australia. Semi-detached, row and terrace houses, and townhouses are included within 'Units' in the Author analysis, but not in the Ong et al analysis.

Sources: Author analysis based on CoreLogic data; ABS Census 2006 and 2016; ABS 8731.0 Building Approvals; Ong et al (2017) Spatial and Temporal Patterns in Housing Supply: A Descriptive Analysis.

Our analysis suggests that the supply of new units is very different to the supply of new houses. Most unit approvals occur in LGAs in the middle- and higher-price weighted price deciles, whereas for houses more approvals occur in LGAs in the lower and middle deciles.

Our results still differ markedly from those of Ong et al, which finds that new units construction is heavily weighted towards the top three unit price deciles. In Ong et al's analysis, in 2015-16 the top three deciles accounted for roughly 90 percent of all new unit supply. We find that the top three deciles only accounted for 58 per cent of new unit supply in 2016-17. And while supply was low in the bottom half of deciles, it still contributed to 17 per cent of all new units constructed.

Even more so than with houses, unit approvals tend to be concentrated in a smaller number of LGAs with a large housing stock, such as Brisbane City Council, City of Gold Coast, Canterbury-Bankstown and the City of Sydney. So failing to weight unit price deciles by the existing housing stock, as in the Ong et al paper, results in the misleading conclusion that unit approvals are highly concentrated in the most expensive LGAs.

According to our analysis using weighted price deciles, the supply of new units has changed over time. In 2016-17, a larger share of new units were approved in LGAs in the 9th and 10th weighted price deciles compared to 2005-06, while fewer units were approved in the lowest price deciles.

Figure 8 shows the distribution of the supply of new units in NSW and Victoria.

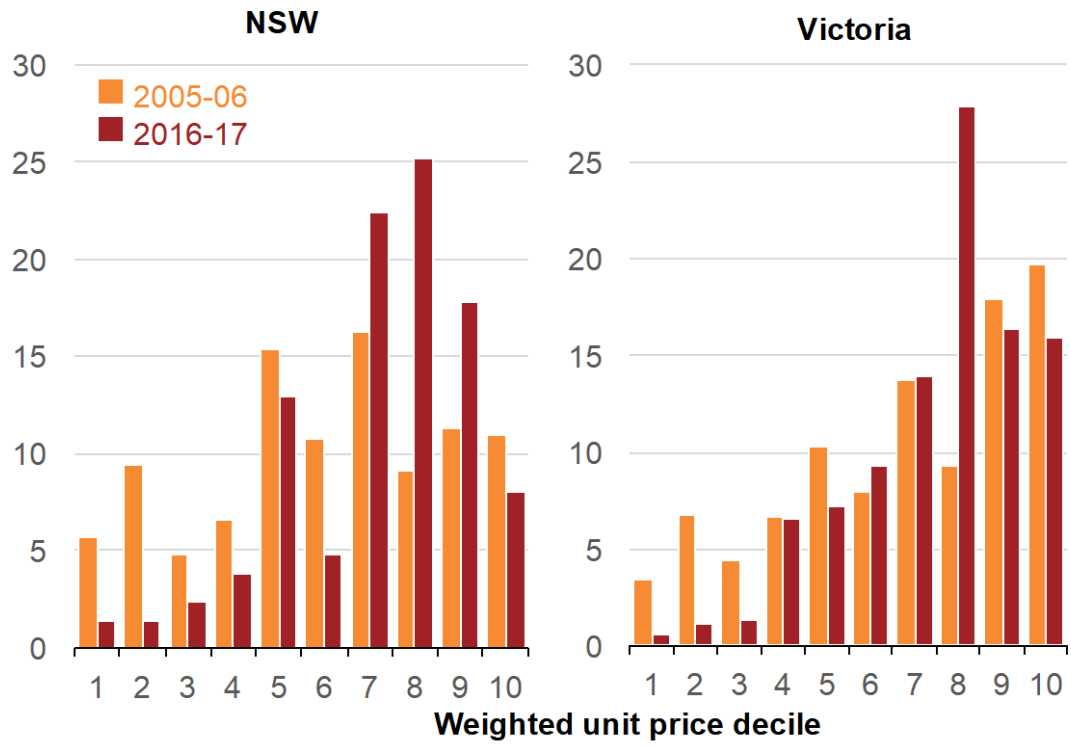
Within NSW, the distribution of unit approvals differs noticeably from house approvals, a contrast similar to the one seen in Australia as a whole. Most unit approvals in NSW in 2016-17 were within LGAs in the seventh and eighth weighted price deciles (a price range of $580,604 to $780,792). Within the top four price deciles, the LGAs with the most unit approvals in 2016-17 were Sydney and Parramatta. Other key development areas were Sutherland Shire, The Hills Shire and Canterbury-Bankstown. There was a noticeable shift towards more unit approvals in higher price deciles between 2005-06 and 2016-17. The top four deciles only made up 47 per cent of approvals in 2005-06; this increased to 73 per cent by 2016-17.

It is no surprise that new units and apartments tend to be built in more expensive LGAs. New units have been approved in LGAs closer to (and including) the Sydney CBD. These areas are more desirable because they are closer to higher-paying jobs and better transport options. Hence the median prices are highest. This aligns with Charter Keck Cramer data which show that there has been an apartment construction boom in Sydney's middle ring in the past few years (Daley et al., 2018). That boom has been driven by a number of factors, including: the higher cost of greenfield land making infill development more attractive; greater use of independent panels to assess development applications by local councils; restrictions on residential development in the Sydney CBD; and the creation of 'priority precincts' around transport corridors (Kent and Phibbs, 2017, Daley et al., 2018).

The distribution of new units is different to the distribution of new houses, where the key areas of new supply were mostly in the outer-suburban LGAs.

Figure 8: Most new units are being built in more expensive LGAs in Sydney and Melbourne

Share of new unit approvals (per cent) in 2005-06 and 2016-17, ranked by median unit price deciles within each state



Note: Price deciles are calculated on median unit prices in each LGA within each state
Sources: Author analysis based on CoreLogic data; ABS Census 2006 and 2016; ABS 8731.0 Building Approvals.

As with NSW, in Victoria most new units have been built in more expensive areas. Between 2005-06 and 2016-17 the share of unit approvals in the top five weighted price deciles increased from 69 per cent to 83 per cent. However, unlike NSW where the supply of apartments was distributed across multiple LGAs, in Victoria the changes in supply were almost solely driven by more unit approvals in the City of Melbourne, which sits in the eighth weighted price decile. Between 2005-06 and 2016-17 the number of unit approvals in Melbourne increased from 140 to 5921 (ABS, 2018b). The boom in Melbourne CBD apartments was driven by a number of factors. On the demand side, the growth reflects changing housing preferences, as well as strong CBD employment and increasing land prices making apartments (where the land component of the price is lower than for a detached house) relatively more attractive (Daley et al., 2018). However it also resulted from planning changes which gave the Victorian Planning Minister the discretion to approve high-rise inner-city developments more readily than housing in the suburbs, where planning decisions are made by local councils (Shoory, 2016).

HOUSING SUPPLY AND FILTERING

Overall, our analysis shows that the supply of houses has occurred within low- and mid-priced LGAs, while most new units have been approved in higher-priced LGAs. These patterns generally hold at the national and within NSW and Victoria.

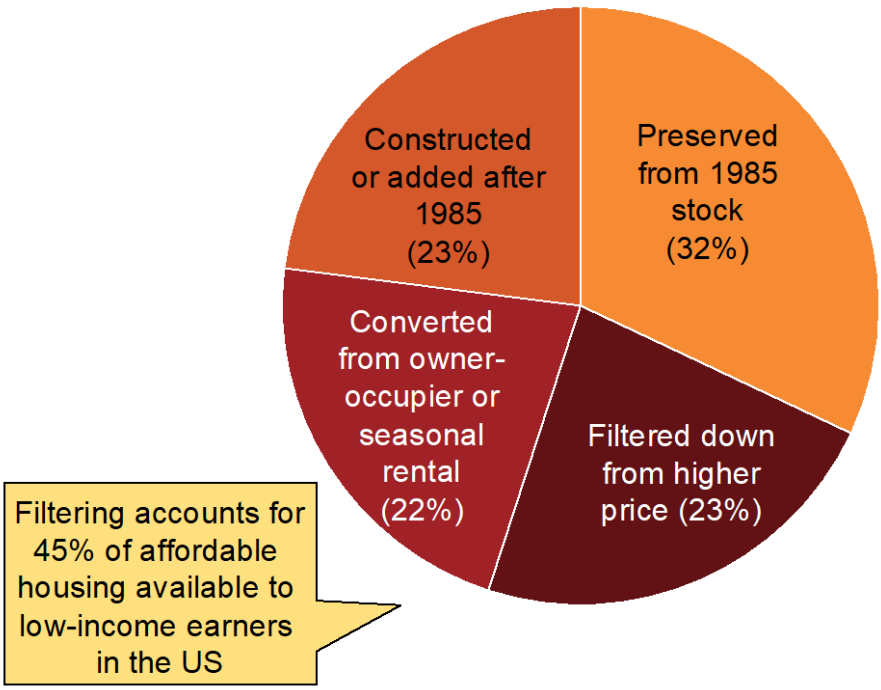
But even though a lot of new housing is being built in cheaper areas, new housing needn't be targeted at lower price points to improve overall housing affordability. While building new social or affordable housing does directly help the lower-income households

who get access to these homes, more housing supply — even at the top end — should ultimately "filter" down and free up less expensive housing stock.

The people who move into newly constructed, more expensive housing are either existing residents who move out of less expensive housing, or new residents who would otherwise have added to the demand and pushed up the price for existing housing. Irrespective of its cost, each additional dwelling adds to total supply, which ultimately affects affordability for all homebuyers.

There is good international evidence to suggest that "filtering" does occur in practice. (Rosenthal, 2014) finds that the U.S. housing stock "filters down at a rate of roughly 1.9 per cent per year in real terms. At that rate the real income of an arriving occupant in a 50-year-old home would be 60 per cent less than income of an occupant in a newly built home".

Figure 9: Filtering is an important source of affordable housing for low-income earners
US affordable rental housing stock in 2013 by source



Notes: Affordable housing is defined as costing no more than 30 per cent of income for households with very low incomes (earning less than 50 per cent of area median). Units added include rentals that were temporarily out of the stock in that year.
Source: Weicher, Eggers and Moumen (2016), The Long-Term Dynamics of Affordable Rental Housing.

Figure 9 shows that 45 per cent of homes that were affordable to very low-income earners in the US in 2013 had filtered down from owner-occupier or higher rent categories in 1985 (Weicher et al., 2017). Expensive homes gradually became cheaper as they aged, and were sold or rented to people with more modest incomes. Without those extra homes, far less affordable housing would have been available to low-income earners.

Additional studies from the California Legislative Analyst's Office and the Federal Reserve Bank of New York reach similar conclusions about the effectiveness of filtering in the US (Taylor, 2016, Somerville and Mayer, 2003).

Unfortunately, there is little Australian literature on filtering. Australia lacks an equivalent to the American Housing Survey.[10] The last dedicated survey of the Australian housing stock was conducted almost two decades ago. Nor do we know what happens to particular homes over time. But it's likely that market-rent housing is an important source of affordable housing here, as it is in the US.

Of course, new expensive housing might not improve the balance between supply and demand if it merely induces additional demand, presumably from overseas purchasers. But there is little evidence that overseas purchasers are increasing demand in Australia by much more than they increase supply (Daley et al., 2018) (Wokker and Swieringa, 2016). There is clear evidence that they are not the only purchasers of more expensive housing. And while gentrification can push up prices in a particular area, the construction of more housing in total should lead to prices lower than otherwise.

However filtering may be slower if house prices rise rapidly and overall housing supply is restricted (Somerville and Mayer, 2003).[11]

The findings from the international literature underscore the importance of more housing supply to keep housing affordable for low-income earners — even if much of the new housing is too expensive for them. Australian research on filtering would also be welcome.

CONCLUSION

Our research shows that most new housing supply is not targeted at the top end of the market. By using price deciles weighted by the existing housing stock, and thereby correcting a flaw in Ong et al's analysis, we show that most new houses are being built in cheaper suburbs on the fringes on our major cities, and most new units are being built in the inner and middle rings of Sydney and Melbourne. Our findings on new house approvals, and to a lesser extent the supply of new units, rebut Ong et al's conclusion that "[h]ouse and unit supply is concentrated in LGAs that have relatively high prices".

We also review the international evidence on filtering and conclude that filtering is an important source of housing for low-income households in the US. Impediments to new housing supply slow the filtering process.

Our findings add to the growing evidence that new housing supply will improve housing affordability, including for low-income earners. Housing supply isn't the only solution to make housing more affordable for low-income earners. Larger subsidies are needed to help low-income earners cope with rising housing costs. But without more supply for everyone, housing won't become much more affordable.

[10] The American Housing Survey has tracked a consistent set of homes, and the characteristics of those who live in them, every two years since 1985.

[11] "Restrictions on the supply of new units lower the supply of affordable units. This occurs because increases in the demand for higher-quality units raise the returns to maintenance, repairs, and renovations of lower-quality units, as landlords have a stronger incentive to upgrade them to a higher-quality, higher-return housing submarket."

REFERENCES

ABS 2005. 1216.0.15.002 - Australian Standard Geographical Classification (ASGC) Concordances, 2005 Australian Bureau of Statistics.

ABS 2016. Census of Population and Housing. Australian Bureau of Statistics.

ABS 2017a. 8752.0 - Building Activity, Australia, Dec 2017 - Glossary. Australian Bureau of Statistics.

ABS 2017b. Regional Population Growth, Australia, 2015-16. Australian Bureau of Statistics.

ABS 2017c. Regional Population Growth, Australia, 2016. Australian Bureau of Statistics.

ABS 2018a. Building Approvals, Australia, Feb 2018 - Glossary. Australian Bureau of Statistics.

ABS 2018b. Building Approvals, Australia, Jan 2018. Australian Bureau of Statistics.

CORELOGIC 2015. Quarterly Review: The Australian Residential Property Market and Economy.

DALEY, J. 2016. Productivity and geography. *Productivity Commission Conference, Canberra.*

DALEY, J., COATES, B. & WILTSHIRE, T. 2018. Housing affordability: re-imagining the Australian dream. Grattan Institute.

DALEY, J., WOOD, D. & CHIVERS, C. 2017. Regional patterns of Australia's economy and population. Grattan Institute.

GLAESER, E. L. & GYOURKO, J. 2018. The economic implications of housing supply. *Journal of Economic Perspectives,* 32**,** 3-30.

GURRAN, N., RANDOLPH, B., PHIBBS, P., ONG, R. & ROWLEY, S. 2018. Affordable housing policy failure still being fuelled by flawed analysis. *The Conversation,* 15 March 2018.

HILBER, C. A. L. & VERMEULEN, W. 2015. The Impact of Supply Constraints on House Prices in England. *The Economic Journal,* 126**,** 358-405.

HWANG, M. & QUIGLEY, J. 2006. Economic Fundamentals in Local Housing Markets: Evidence from U.S. Metropolitan Regions. *Journal of Regional Science,* 46**,** 425-453.

INFRASTRUCTURE AUSTRALIA 2018. Future Cities: Planning for our growing population. Infrastructure Australia.

KELLY, J.-F., WEIDMANN, B. & WALSH, M. 2011. The housing we'd choose. Grattan Institute.

KENDALL, R. & TULIP, P. 2018. The Effect of Zoning on Housing Prices. *RBA Research Discussion Paper.* Reserve Bank of Australia.

KENT, J. & PHIBBS, P. 2017. Three charts on: crane-spotting, a way to tell which Australian cities are growing and where. Available: https://theconversation.com/three-charts-on-crane-spotting-a-way-to-tell-which-australian-cities-are-growing-and-where-76776.

KULISH, M., RICHARDS, A. & GILLITZER, C. 2011. Urban Structure and Housing Prices: Evidence from Australian Cities. *In:* AUSTRALIA, R. B. O. (ed.) *Research Discussion Paper.* Reserve Bank of Australia.

LEES, K. 2017. Quantifying the impact of land use regulation: Evidence from New Zealand, Sense Partners, Report for Superu, Ministerial Social Sector Research Fund.

OECD 2010. OECD Economic Surveys: Australia 2010. OECD.

ONG, R., PHELPHS, C., ROWLEY, S. & WOOD, G. 2017. Spatial and Temporal Patterns in Housing Supply: A Descriptive Analysis. *Urban Policy and Research.*

PRODUCTIVITY COMMISSION 2011. Performance Benchmarking of Australian Business Regulation: Planning, Zoning and Development Assessments. *Productivity Commission Research Report.* Productivity Commission.

PRODUCTIVITY COMMISSION 2017. Realising the Productive Potential of Land, Shifting the

Dial: 5 year Productivity Review, Supporting Paper No. 10.

QUEENSLAND GOVERNMENT 2010. QLD Local Government Authorities (current and pre-reform). *In:* GOVERNMENT, D. O. L. (ed.).

REALESTATE.COM.AU. 2018a. *New house and land packages for sale in QLD* [Online]. Available: https://www.realestate.com.au/house-and-land-packages/qld/?source=srp-search [Accessed].

REALESTATE.COM.AU. 2018b. *New house and land packages for sale in VIC* [Online]. Available: https://www.realestate.com.au/house-and-land-packages/vic/?source=srp-search [Accessed].

REALESTATE.COM.AU. 2018c. *New house and land packages for sale in WA* [Online]. Available: https://www.realestate.com.au/house-and-land-packages/wa/?source=srp-search [Accessed].

ROSENTHAL, S. S. 2014. Are private markets and filtering a viable source of low-income housing? Estimates from a "repeat income" model. *The American Economic Review,* 104**,** 687-706.

SHOORY, M. 2016. The Growth of Apartment Construction in Australia. *RBA Bulletin.*

SOMERVILLE, C. & MAYER, C. 2003. Government Regulation and Changes in The Affordable Housing Stock. Federal Reserve Bank of New York.

TAYLOR, M. 2016. Perspectives on Helping Low-Income Californians Afford Housing. Californian Legislative Analyst's Office.

UDIA 2017. 2017 State of the Land. Urban Development Institute of Australia.

WEICHER, J., EGGERS, F. & MOUMEN, F. 2017. The Long-Term Dynamics of Affordable Rental Housing. Hudson Institute.

WOKKER, C. & SWIERINGA, J. 2016. Foreign Investment and Residential Property Price Growth. The Treasury.

FLYING UNDER THE RADAR: EXPLORING RESISTANCE AND BECOMING MINOR IN AUSTRALIAN TINY HOUSE TRENDS

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Griffith University, Gold Coast, Australia

Abstract
Described in various ways as a return to simplicity and authenticity; an architectural and social response to the growing size, economic costs and environmental burden of the average American home, the 'tiny house movement' has emerged in the public consciousness only in recent years. Drawing on interviews, case studies and various social media this paper examines the tiny house movement in Australia and the ways in which it falls between the established boundaries of accepted housing forms and practice often characterised as the Great Australian Dream. Here, tiny houses and their occupants inhabit the interstitial spaces or grey areas within regulated spaces by 'flying under the radar' which I argue works as a spatializing or interstitial practice which illuminates borderlands and edge worlds. Following the work of Deleuze and Guattari on *Kafka: A minor literature*, I explore becoming minor, or conditions of minority and the ways a minor works to deterritorialize the major. I use these ideas to conceptualise tiny housing as an expression of difference affecting a productive engagement with the dominant or major housing practice rather than merely an oppositional component in the struggle between unequal things. Further, I propose that as 'a becoming minor' tiny house trends work creatively and experimentally with the given set of social and material conditions and possibilities offered causing them to transform and mutate producing new sets of relations with unexpected possible potentials.

Keywords: Tiny houses; informal housing; assemblage; becoming minor; resistance.

Vicki Weetman is a PhD candidate at Griffith University, Gold Coast. Her doctoral thesis is an interdisciplinary project exploring the tiny house movement in Australia. Her research interests include community, DIY, epistemic intersections and the politics of everyday life.

INTRODUCTION

The contemporary tiny house movement began in the United States in the late 20th century and has been self-described as a social and architectural movement. Tiny housing in this form has only emerged in Australia in recent history and is very much 'in the moment', often reported as a rapidly growing phenomenon numbering in the tens of thousands. These figures, however, are usually derived from the number followers on various dedicated Facebook sites. While it is ubiquitous online and in the public media on the ground, the number of tiny house dwellers both in the United States and Australia is significantly smaller locating the 'movement' as a largely online phenomenon. Over the course of my research, I have found that contemporary tiny housing in Australia can best be described as nascent though there are signs of growth. Tiny house proponents estimate that there are, at best, between 100 and 150 tiny houses that are built or being built in Australia. In terms of actual lived experience, my research has thus far only accounted for roughly fifty to sixty currently occupied tiny houses in Australia (although this figure is increasing and does not include the proportion of tiny house dwellers who remain hidden from social media).

Ordinarily articulated as home ownership, the Great Australian Dream (hereafter GAD) can be better conceptualised as an assemblage; a form composed by affective relations between heterogeneous wholes and parts which include the human, non-human, natural, technical, material and immaterial. The GAD as assemblage intersects with a proliferation of other assemblages expressed as capitalisations that perpetuate our economic structures (mortgages, rates and taxes, insurance); building industries and spheres of design, architecture and planning; various texts; expressive acts; embodied experience and cultural notions of 'a haven', 'a retreat', 'a right of all citizens', 'a security for the future' and 'a national concern'.

I am particularly interested in how the circulating processes, relations and parts of a tiny house assemblage might re-imagine or re-construct the GAD and what effects this engagement might have on the social, political and cultural landscape. In this paper, I will discuss tiny houses as an informal housing practice which operates as a particular type of assemblage namely a minor architecture and what implications this might have for major architecture like the GAD.

PROCESS

This discussion is drawn from my current doctoral research which examines tiny housing trends in Australia alongside the GAD. To do this I make use of a number of concepts deployed by Giles Deleuze and Felix Guattari (hereafter D&G) chiefly, assemblage and becoming minor to work with movements among and between ideas, events and situations, and to draw out relations and/or disjunctions that arise within flux and change. My research is qualitative, broadly ethnographic and emergent. Through multiple methods I am seeking to produce a mapping that is facilitated through various flows – crossing online and offline surfaces, via websites, blogs, social media platforms, books, magazines, television and YouTube Channels, local area meetings, workshops, expos and seminars, conversations and the everyday lived experience of tiny house dwellers.

BECOMING MINOR

My theoretical and methodological approach to the contemporary tiny house phenomenon is largely informed by D&G's work on becoming minor, or conditions of minority. In utilising the concept of a minor architecture, I am considering the ways in which tiny housing trends decompose what might be called the immaterial 'standards of architecture', or the models by which the majority must conform. Jennifer Bloomer

argues that this standard emerges in language and discourse. To use a paraphrase of D&G, [t]he minor works to recognise and release a multitude of whole other stories vibrating within the arguments and claims of the major (Barry 2017, D&G1986). Positioning the tiny house phenomenon as a minor architecture raises questions about the spaces it opens up in the dominant and normative narrative of housing and housing practices in Australia alongside broader cultural notions of 'a haven', 'a right of all citizens', and 'a security for the future'.

Essentially, a minor [literature, architecture, theory] operates on the basis of difference, not a quantitative majority, for example, the number of women in the world as against the number of men quantitatively positions them in the majority yet the dominance of patriarchy re-positions women as the minority (D&G 1986; 1987). It is important to note however that a minor should not be confused with, social status such as a minority or other traditional forms of identity politics although a minor is intensely political and operates at the bottom of power structures. D&G (1987, p.106) work to clarify their complex and abstract concept of a minor through definitions of the major as the power (*pouvoir*) of constants and the minor as the power (*puissance*) of variation. In this manner, the major becomes the 'model' which fits no-one but to which all must conform while the minor is a becoming process, a possibility for everyone, one's potential becoming to the extent that one deviates from the model. This understanding is further developed by D&G (1987, p. 106) through their formation of the hyphenated term becoming-minor since minors are always becomings. A major can never be a becoming since its power, dominance as the model is through stasis and resistance to change. A minor is able to be included in the majority (as an architecture, as a dream, as a right) however, "contains within in it a high coefficient of deterritorialization" (D&G 1986, p.16).

It might be helpful to note that in their use of the concept becoming-minor D&G play on the French word 'mineur' (miner) one who works by excavating the earth from underneath the surface. In producing their own kind of assemblages, minors deterritorialize one territory while they map another (D&G 1986; Katz 1996). Rather than becoming a counter project a minor, reworks and decomposes the major from within. Minor architectures, therefore, are primarily concerned with performance not about a particular architectural form. This is not to say that material aspects are not implicated, as a type of performance, particularly tiny house building practices that incorporate nonstandard materials and forms such as shipping containers, house trucks, yurts, tree houses etc. What a tiny house looks like or what it is made out of, however, is peripheral to what it can do and the ways it functions as a node in a network of different and resistant practices that either challenge or rupture the major.

Within the current and exiguous scholarship on the contemporary tiny house movement - there is a valid argument that, as a movement, tiny housing is blind to its own privilege, and that it represents normative marketplace property ownership - the neoliberal project and by extension major architecture (Anson 2014; D'Amico 2016). While I agree that there are to paraphrase April Anson (2014, p. 293) capitalisations upon the ethos of tiny housing I would argue that it does not conform to normative marketplace property ownership nor do tiny house dwellers experience property ownership in the same way as those in standard housing forms. Some twenty years after it first emerged the contemporary tiny house in form and practice continues to be informal and unregulated, there is as yet no specific legislation for the building of, or habitation of a tiny house as a primary dwelling, nor is there a real estate market for tiny houses that offer any appreciable capital gains. The work of Jill Stoner (2012, p.15), on minor architecture, emphasizes this point stating that:

Minor architectures operate from outside the major economy, potentially outside the architectural profession, and outside prevailing critical frameworks – outside these dominant cultural paradigms, but inside architecture's physical body.

Acting critically upon the 'model' of the GAD tiny house dwellers are, through the process of becoming minor, framing a new narrative rather than feeling forced to live under a narrative that is not their own. These becoming minors emerge from the interstices, and are always on the brink of disappearing yet, they are full of revolutionary potential (Katz 2015).

MOBILITIES

As a pro-mobilities policy model, neoliberalism encourages residential mobility via the GAD as a means for individuals to take control of their own upward social mobility. Affordability and its varied meanings remain at the forefront of Australian political, housing, social benefit debates. Embedded in this framework are powerfully hierarchical issues of identity, gender, age, class, and regionality. Through affordability discourses, the GAD is becoming an issue of immobility for many Australians, a literal impasse. Public media often makes reference to the Great Australian Nightmare that stifles the dream of the good life and can wear people out in the everyday. It can be argued that the emerging trend of tiny houses is a direct response to housing affordability or unaffordability as tiny house advocates often refer to it. The motives they offer for their choice to live tiny however are broader and more nuanced then not being able to afford a 'regular house' or even using it as a step on the way to the 'regular house'. Indeed, a significant portion of the participants in this study do have the means to jump on the housing ladder yet defend their move to live tiny as a 'lifestyle choice'. The standard model of a thirty-year mortgage requiring dual incomes to service it is not a lifestyle or life narrative they want to embrace. They believe that there is simply not enough diversity in the current housing configurations for those who wish to live within their means – live in ecologically responsible ways, live off-grid, live migratory or nomadic lifestyles.

Their desire to build and live in a tiny house means that they dwell informally, interstitially and precariously (flying under the radar) in the grey areas of urban and peri-urban zoning regulations and building codes. I argue that for the participants in my study the tactic of flying under the radar is a spatialising practice which represents a creative and generative action of holding open the impasse operating as the GAD in that there is a "spatiality to their politics" (Massey 1994). It is not, however, a welcome spot or an open door and it is continually underlined by threat. There is no certainty in their existence, nor do they appear to need it. The conditions of uncertainty and threat frames such tactics as enacting a minor politics whereby "immanent and elusive space or the impasse is the condition and aim of becoming minor" (Secor and Linz 2017, p. 568). Here I am drawing on re-configured understandings of the impasse as an opening and not a dead end. To quote:

"It is the shift in gears. It is the time-out. But this does not mean it is nowhere or that it is merely a holding station or a [spacetime] of hibernation. It is the opposite. This is the site of gestation that allows something very different to emerge from the other side" (Secor and Linz 2017, p. 569).

RESISTANCE IS FERTILE

The poster child for the tiny house movement, the 'tiny house on wheels' (hereafter THOW), materially embodies regulatory ambiguity and the intentions of its occupants to eschew legal boundaries. It is a hybrid house with metaphorical roots and wings, built on a trailer (wings) in order for it to be classified as a caravan. The aesthetic and animus of

a tiny house, however, are that it is not a caravan but a real house (a forever home with roots). A position strongly held by this study's participants when asked. "Why not just buy a caravan"? It is a question that provokes a couple of responses mainly, that there is a temporal superficiality to caravans as a 'leisure' object/item followed closely by aesthetic sensibilities concerned with a caravan's 'non-home' like attributes – that they are massed produced, homogeneous, plastic filled containers suitable for camping but not dwelling. Despite being constructed for mobility tiny house dwellers *intend* for their tiny house to be a fixed dwelling. The construction of a house on wheels is largely for the purpose that it allows it to be comparatively classed as a caravan in order to bypass building regulations for habitable dwellings.

Alongside their motivation to create and live in alternative housing forms many tiny house dwellers also engage in informal barter and exchange economies and explore co-housing or communal property arrangements. Their lived, everyday choices radically question consumption and accumulation practices, notions of property and property ownership, sustainability; and ecological responsibilities. The participants in my research do not perceive themselves as being intentionally transgressive they are simply unwilling to engage with a system that in their opinion has become over-coded and inflexible. Their choices and everyday practices reflect deeper values of lifestyle, autonomy, resourcefulness and resilience. These motivations toward simplicity, sustainability, freedom and deeper expressions of community, commonly found amongst tiny house dwellers, alongside a penchant for THOW designs that resemble cookie cutter cottages or frontier cabins have given rise to characterisations which frame tiny house practices as romanticism or nostalgia, only accessible to privilege. Anson (2014, p. 291) in her thesis based on her personal experience of tiny house living calls this Thoreauvian rhetoric, an 'invocation' of Henry David Thoreau's own experiment in small cabin living and penned with utopian prose in his book *Walden.* Her work seeks to find the relevance of this rhetoric amidst what she terms "the sharp corners of tiny house living" (Anson 2014, p. 291).

According to Nigel Thrift (1997, pg. 124), the label of 'romanticism' or 'nostalgia' is one of the challenges facing practices of resistance. In *Geographies of Resistance* (1997) scholars such Steven Pile, Gillian Rose and Thrift present new understandings of resistance. Their notions of resistance take account of political identities and political actions that are not solely formed by the effects of the dominant power (Pile 1997, p.1). It is geographical in that it seeks to occupy new spaces, its own place on the map (Pile 1997). Drawing on the work of Walter Benjamin and Michel de Certeau and their interest in everyday practices, Thrift (1997, pg. 125), argues that resistant geographies, or practices of resistance, are reconfigured everyday practices that draw upon different knowledges from those relied upon by the dominant order. As such they carry potential for transformation.

The everyday lived experience of the participants in my study represent multiple and simultaneous routes of resistance, that are always changing across space and time. Despite online representations as a 'unified movement' on the ground, the unfolding day to day embodied and quiet resistances of individual participants do not represent a united or pre-meditated route of struggle. The resistant effects of their efforts, however are not immobilized by this apparent atomization, rather as Asef Bayat (cited in Murray 2016, p. 228) found in his work that the "simultaneous and concerted pressures of multiple actors" (what might be otherwise observed as uncoordinated, diffuse or barely perceptible micro-actions) "create a density of resistance that, together, is sufficient to challenge systemic inequalities". In this way, these resistances can, take diverse forms and move in different dimensions; create autonomous zones as a strategy against particular dominating power

relations, open up unexpected networks, connections, invent new trajectories or articulate alternative futures and possibilities (Pinder 2005; Thrift 1997; Bayat 2010).

CONCLUSION

Arguably, from its genesis, the contemporary tiny housing movement is articulated and mobilised by forms and practices of resistance, and are imagined, built and inhabited in interstices of the normative housing forms and practices. It is an ordinary and everyday resistance that reinvigorates dreaming and offers tiny house dwellers new possible futures. These routes of resistance are not counter projects but internal displacements effecting a spatial politics that opens up the cramped spaces of life. As Cindi Katz (1996) reminds us, If the minor is charged with political immediacy and possibility what might that mean? For practice? For the production of knowledge? Further, I have argued that these displacements are the performative functions of a minor architecture, having conditions of minority which decompose the representative functions of a major architecture as delineated by the GAD, and in doing so produce new sets of relations with the potential for different knowledges inviting discussion of their potentials and capacities for transformation.

REFERENCES

Anson, A. (2014) '"The World is my Backyard": Romanticization, Thoreauvian Rhetoric, and Constructive Confrontation in the Tiny House Movement', in Holt, W. G. (ed.) *From Sustainable to Resilient Cities: Global Concerns and Urban Efforts*. Emerald Group Publishing Limited, pp. 289–313. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/S1047-004220140000014013 (Accessed: 8 September 2015).

Barry, A. (2017) 'Minor political geographies', *Environment and Planning D: Society and Space*, 35(4), pp. 589–592.

Bayat, A. (1997) 'Un-civil society: The politics of the "informal people", *Third World Quarterly*, 18(1), pp. 53–72.

Bloomer, J. (1989) *Towards An Architecture Of Desire: The (S)Crpt of Joyce And Piranesi*. Georgia Institute of Technology.

Deleuze, G. and Guattari, F. (1986) *Kafka Toward a Minor Literature*. Translated by Polan, Dana. Minneapolis: University of Minnesota Press (Theory and History of Literature).

Deleuze, G. and Guattari, F. (1987) *A thousand plateaus: capitalism and schizophrenia*. Repr. Translated by B. Massumi. Minneapolis: University of Minnesota Press.

Katz, C. (1996) 'Towards minor theory', *Environment and Planning D: Society and Space*, 14(4), pp. 487 – 499.

Massey, D. B. (1994) *Space, place, and gender*. Minneapolis: University of Minnesota Press (Book, Whole). Available at: https://ebookcentral-proquest-com.libraryproxy.griffith.edu.au/lib/griffith/detail.action?docID=310284.

Murrey, A. (2016) 'Slow dissent and the emotional geographies of resistance: Slow dissent', *Singapore Journal of Tropical Geography*, 37(2), pp. 224–248.

Pile, S. and Keith, M. (eds) (1997) *Geographies of resistance*. London; New York: Routledge.

Pinder, D. (2005) *Visions of the city: utopianism, power, and politics in twentieth-century urbanism*. New York: Routledge.

Secor, A. and Linz, J. (2017) 'Becoming minor', *Environment and Planning D: Society and Space*, 35(4), pp. 568–573.

Stoner, J. (2012) *Toward a Minor Architecture.* Cambridge, MA, USA: MIT Press. Available at: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10537986 (Accessed: 10 August 2015).

TEDx Talks (no date) *The Tiny House Movement*. Cristina D'Amico. TEDxUofT. Available at: https://www.youtube.com/watch?v=QWVgsK7Uu3k (Accessed: 2 April 2018).

AN AFFORDABILITY REVIEW FOR LOW-COST APARTMENT RENT

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Abstract
The low-cost apartment development program is one of the solutions to provide housing for low-income people. During 2010–2014, the Indonesian Ministry of Public Works and Public Housing developed 250 twin blocks of rental low-cost apartment (five-storeys) on the local government's asset land for public and relocation communities. The aim of this paper is to review the existing rent regulation and tenant's affordability to pay rental fee. The evaluation is also included tenants' willingness to pay and the implication on the low cost apartment management issues. This research based on the documents related to ministry and local government regulations concerning minimum wages and rent price adjustment. This study found that there is a gap between what the tenants' ability and willingness to pay. The tenants only pay half of the price that they supposed to pay based on the existing regulation of rental price. As consequences, the rent income is very low and cannot cover the operation and maintenance cost of the building. Therefore, local government has to provide subsidy to top up the rent income and to cover the operation and maintenance costs. The study recommends the evaluation of local government regulation is necessary to reduce government subsidy and to retain more appropriate level of rent that still consider affordable for the tenants.

Keywords: low-cost apartment, Surabaya, storey, government policy

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INTRODUCTION

In the Medium-term Development Planning, Indonesian Ministry of Public Works and Public Housing (Ministry of PUPR) declared that housing backlog in Indonesia reach 800,000 units per year. The housing supply comes from the local government, developers and community, which reaches 400,000 units per year. This condition has adding the housing backlog 13.5 million units by year 2014. One of the initiatives is low-cost apartment development program, which provide a healthy and affordable residential for low-income community and to reduce illegal slum areas. During 2010 – 2014, the government have built 43,170 low-cost apartment units, while 550,000 units will be developed by year 2014-2019 (Ministry of PUPR, 2014).

Existing low-cost apartment in Indonesia were built by Ministry of PUPR on the local government's land. Then, local government manages the low cost apartment. The local government regulates the rent price based on ministry of PUPR's guidelines for each low-cost apartment. Most low-cost apartment are allocated for relocation community and low-income people, which do not have the willingness to pay the rental fee regularly and properly. Thus, local government makes some adjustment regarding tenants' ability and willingness to pay.

The main revenue of rental low-cost apartment is derived from tenants contributions by paying the rent price monthly. This revenue is used to pay the operation and maintenance costs of the apartment. The average rental fee for low-cost apartments managed by the local Government (province, district, municipal) is AUD$ 2 – AUD$ 10 per month. One of the problems is the low rental price based on their willingness to pay rate (Rachmawati, Soemitro, Adi, & Susilawati, 2015). Willingness to pay (WTP) is defined as a positive attitude for the community to pay bills (Ntengwe, 2004). As a result, local government needs to subsidise the maintenance cost in a large amount.

Generally, the rent determination analysis is aimed to ensure that it will recover the financial cost. It should meet the affordability and the cost recovery. Considering that low-cost apartments are dedicated to low-income groups, that rental price may not be kept high (Bing, Akintoye, Edwards, & Hardcastle, 2005). The objective of the rent price determination is to achieve a balance condition among revenue sufficiency, equity and poverty alleviation (Whittington, 2003).

According to the U.S. Department of Housing and Urban Development (HUD), affordable housing is defined as the housing costs that consume less than 30% of a household's budget. It means that, each family has to allocate 70% of its income to other needs, such as food, education, cultural needs, clothing and even leisure time and entertainment. If one family allocates less than 30% of its income including utilities and taxes to the house rental, the house is affordable. Therefore, this definition will be used to calculate an affordable rent price.

Australian Government consider those housing as 'affordable housing' whose owners and/or residents do not spend more than 30% of their total earning as valuation of their repayment installment for purchase of the house or payment of rental every month (Wood, Ong, & Cigdem, 2014). Meanwhile, Malaysian government classified the housing by the income and location. For example, for people with income RM 1200-1500, they deserve to buy/rent a more than five storeys apartment in cities or town centre. In contrast, for people with income RM 750-1000, they are not allowed to buy/rent a house in cities (Goh & Yahaya, 2011).

This study will review the existing rent regulation and tenant's affordability to pay rental fee. The evaluation is also included tenants' willingness to pay and the implication on the low cost apartment management issues to the operation and maintenance cost. This study analyses quantitative data gained by the documents related

to ministry and local government regulations concerning minimum wages and rent price adjustment. Prior discussion on findings and discussion, next section illustrates methods and technique. The last two sections present and discuss the result and recommendation, then conclude the paper.

MATERIAL STUDIED

Indonesia has three tiers of government: Indonesian government is the first tier, provincial government is the second tiers, and district/municipal government is the third tiers. East Java Province, which is one of 34 provinces in Indonesia has a total population of 38.8 million in 2015 and is divided into 29 districts and 9 municipals (Statistic Bureau-East Java Province, 2016). Surabaya is the capital city of this province, which the total population in 2016 was 3 million, and 40% of these are migrant inhabitants (Statistic Bureau-East Java Province, 2016). As local government, Surabaya Municipal Government proposes the Indonesian government through Ministry of Public Works and Public Housing (PUPR) to construct the low-cost apartment to meet housing needs in Surabaya. The building should be constructed over the local government's legal asset land. After construction process, local government will possess the authority to manage the low-cost apartment, which include tenants' selection, operation and maintenance activities, rent determination and financial management. There are 15 low-cost apartments managed by Surabaya Municipality Government as shown in table 1. More than 93% of the low-cost apartments in Surabaya were built by Ministry of PUPR since the year of 2000.

Table 1. Low-cost apartments in Surabaya and the monthly rent price (in AUD).

No	Low cost apartment	1st floor	2nd floor	3rd floor	4th floor	5th floor
1	Wonorejo	5.57	5.00	4.43	3.58	-
2	Penjaringan Sari II	5.57	5.00	4.43	3.58	-
3	Randu	4.53	4.15	3.68	2.92	2.08
4	Tanah Merah I	4.81	4.34	3.87	3.11	2.17
5	Tanah Merah II	6.89	6.23	5.47	4.43	3.11
6	Penjaringan Sari III	7.17	6.51	5.75	4.72	3.21
7	Grudo	7.55	6.79	6.04	4.91	3.40
8	Pesapen	8.02	7.17	6.42	5.19	3.58
9	Jambangan	8.21	7.36	6.51	5.28	3.68
10	Siwalan Kerto	7.92	7.17	6.42	5.19	3.58
11	Romo Kalisari	5.57	5.00	4.53	4.06	3.68
12	Bandarejo	8.11	7.26	6.51	5.28	3.68
13	Gunung Anyar	8.11	7.26	6.51	5.28	3.68
14	Dukuh Menanggal	8.77	7.92	7.08	5.75	3.96
15	Keputih	9.34	8.40	7.45	6.04	4.25

Most tenants in these low-cost apartments are low-income communities who work as an industrial employee, small trader, cab driver and semi-jobless. Previously, low-income communities in Surabaya have to allocate AUD$50-150 per month to reside in either a boarding house or rented house or own house (with high monthly instalment). In addition, migrant workers, who reside in the suburbs or greater Surabaya (> 10 km) by paying a lower housing price, are required to spend AUD$ 20-50 per month on transportation.

Majority low-cost apartments consists of 1-2 twin blocks. One twin block has 5 floors and 96 units. The first floor is commonly used as commercial area, common room and management office. Low-cost apartment in Indonesia is the four/five-floor apartment of 48-64 units which is constructed with pre-cast panels which completed faster with certain quality products (Kisnarini, 2015). The unit area is 18, 21 or 24 sq.m2. Low-cost apartment units usually has different spaces, three of which: kitchen, bathroom / toilet and balcony are considered as service area; and only one space, namely the multi-functional space which can be utilized as the living area

Having the authority to manage the low-cost apartment, according to Indonesian Act no 20/2011 in the article 56 and 57, local government has to overcome the operation and maintenance activities. Operation and maintenance cost are covered by inhabitants in the form of rent price and government subsidy. Surabaya Government always subsidies the operational maintenance cost monthly as the applied rent price is very low as shown in Table 1.

GOVERNMENT REGULATION REVIEW RELATED TO RENT PRICE

The Indonesian Act no. 20/2011 states that low-cost apartment development is aimed to fulfil housing needs in urban areas with high population density, and it is developed specifically for low-income communities. The classification of low-income communities is not clearly defined. The Indonesian Act no 11/2011 declares that the low-income communities are those who have limitation on ability to pay the house. The government subsidises that group in the form of liquidity facilities on housing finance. This support is dedicated to the workers having income less than 4 million. That restriction unofficially became the definition of low-income communities. However, some developers, financier and real estate affiliations suggest the adjustment of low-income communities' definition based on the region or zoning, as different region will result in the different living cost and provincial minimum wage.

Indonesian Minister of PUPR Regulation no 1/2018 also states that the low-income communities, such as industrial employee, anglers, and the disaster victim are supported to occupy the low-cost apartment. Furthermore, the minister regulation regulates that the rent price determination has to consider the renter's ability and willingness to pay (ATP/WTP).

Indonesian government through Minister of PUPR Regulation no 1/2018 guides a rent determination. The component of low cost apartment rent price consists of operational cost and maintenance cost. The operational cost covers officer salary, tax, insurance and common utilities, while maintenance cost includes building component rehabilitation and component replacement. Furthermore, government regulates two rent determination options:

1. Maximum price, which is determined based on the operational and the maintenance cost. The rent price is obtained by the total cost divided by the number of unit.
2. Minimum price, which only consider the maintenance cost.

However, the rent price determination should not more than 1/3 of the provincial minimum wage issued by the province government. In case of tenants unable to pay the rent price, local government may provide the subsidy.

According to Minister of PUPR Regulation no 1/2018, the rent price is the main income for low-cost apartment. The other source of incomes come from the commercial room lease and public utility lease, such as common room and parking lot. The lease management is controlled by the appointed technical unit under local government authority. This institution is also allowed to generate income from other commercial

events. It is expected that the additional income might increase the operation and maintenance budget to anticipate the immediate maintenance program. Whereas according to Indonesian Minister of Home Affairs Regulation no 19/2016, which states that the low-cost apartment is classified as government's asset. It is allowed to be rented, but the rent determination has to consider the renter's ability and willingness to pay (ATP/WTP). Minister of Home Affairs regulation no 19/2016 also states that land and building value should be the consideration factor in rent determination.

The Indonesian Act no. 20/2011, Indonesian Minister of Home Affairs Regulation no 19/2016 and Indonesian government through Minister of PUPR Regulation no 1/2018 are the legal basis for Head of Surabaya Municipal Government to determine low-cost apartment rent price. The newest regulation regarding the rent price determination is the Head of Surabaya Municipal Government Regulation no 37/2017. This regulation concerns to the 15 low-cost apartments managed by Surabaya government as listed in table 1. This price is not include water and electricity bills. Formerly, the rent price is determined higher than the existing price. Nevertheless, all tenants proposed an exception and refused to pay. The existing rent price could be assumed as the agreed price or the tenant's willingness to pay, as there are some negotiation processes prior to the regulation issued.

FINDINGS AND DISCUSSION

This study will review the rent price determination in low-cost apartment in Surabaya from three perspectives, namely:

1. Tenants' ability to pay
2. The real operation and maintenance cost
3. The existing rent price

This study also carries out one low-cost apartment, namely Penjaringan Sari III as a case study to illustrate the cost and the gap between regulation and the applied price. Figure 1 describes Penjaringan sari III low-cost apartment, which has 96 units and 1 twin-block, with unit are 21 sqm. The main structure is precast panel, while the partition is built from brick structure. This low-cost apartment has five floors, which the first floor is majority allocated for the common area, such as common hall and administration office. There is some units in the first floor, which is dedicated to the elderly and disable people. There are three low-cost apartments in the same area, and this is the third and newest low-cost apartment. Given this low-cost apartment is quite new, the physical condition is much better than the first and second low-cost apartment.

Figure 1. Penjaringan Sari III low-cost apartment.

Tenants' Ability to Pay (ATP)

As mentioned in previous section, this study will use the definition of housing affordability that could be achieved when the price determination is less than 1/3 of the monthly total income. The concept of expenditure for housing also related to the rent or instalment, which should not be more than 30% of the total income (B Bakhtyar, 2013) . This 30% must include water, gas, electricity, sewage, and other utilities. When the monthly carrying cost of a home exceeds 30-35% of the household's income, then the housing is considered unaffordable for that household. This definition of affordable housing assumes that a renter's household does not spend more than 30% of its income on housing costs, including utilities. It means that, if one family allocates less than 30% of its income including utilities and taxes to the house rental, the house is affordable. Also, for homeowners, an affordable mortgage payment is defined as 25% of the household's income, which allows 5% of the income for other costs, such as taxes, insurance, utilities and maintenance (Stone, 2006).

Minister of PUPR Regulation no 1/2018 also declares that the rent price determination should not more than 1/3 of the provincial minimum wage issued by the province government. It means that the maximum rent price is 1/3 of the total income. As Surabaya is a part of East Java Province, the minimum wage abide The Governor of East Java Province regulation. According to The Governor of East Java Province regulation no 75/2017, the minimum wage of Surabaya is AUD$ 333 in the year of 2018. In accordance with the regulation, the cost of housing could be AUD$ 111. This study assumes that this number is the ability to pay for housing provision. In the rent determination context, AUD$ 111 is the maximum price for low-cost apartment unit rent.

The real operation and maintenance cost

According to Minister of PUPR Regulation no 1/2018, the rent price could be determined from the real operation and maintenance cost. This study analyses the operation and maintenance cost of Penjaringan Sari III low-cost apartment. The secondary data related to the component of the operation and maintenance cost is derived from the previous research and the low-cost apartment management office. Both operation and maintenance cost data is taken in the year 2017 with the inflation adjustment 3.72%

Based on Minister of PUPR Regulation no 1/2018, there are two kinds of rent price structure, namely maximum tariff and minimum tariff. The maximum tariff is calculated from the operation and the maintenance cost. Table 2 presents the total operation and maintenance cost of Penjaringan Sari III low-cost apartment in year of 2017.

The operation cost consists of:

1. The officer's salary
2. The electricity bills for public facilities
3. The office equipment

While the maintenance cost is assumed 3% of initial construction cost, which consists of:

1. Replacement of some building components
2. Monthly routine maintenance

Maintenance cost does not include major scale maintenance activities.

The maximum rent price is determined using this formula in equation 1 and the calculation is shown in Table 2.

$$The\ rent\ price = \frac{monthly\ operation + maintenance\ cost}{number\ of\ units} \qquad \text{(eq. 1)}$$

On the other hand, as the minimum rent price only considers the operation cost, the formula should be explained in equation 2 and the calculation is shown in Table 2.

$$The\ rent\ price = \frac{monthly\ operation\ cost}{number\ of\ units} \qquad \text{(eq. 2)}$$

Table 2. The rent price determination.

Items	Total Cost (AUD) to determine maximum rent price	Total Cost (AUD) to determine minimum rent price
Annual Operation cost:		
Administration staff salary, Electricity for public facilities, Office equipment	31,619	31,619
Annual Maintenance cost	46,429	
Annual operation + maintenance cost	78,048	
Monthly operation + maintenance cost	4,222	
Monthly operation cost		2,635
Number of units	96	96
The rent price per unit	67.75	27.45

From the calculation, it can be shown that the range of monthly rent price should be AUD 27.45 to AUD 67.75. AUD 27.45 is determined based on the operation cost estimation, while AUD 67.75 is determined based on the operation cost and the maintenance cost. It must be noted that the investment cost (land and construction cost) excluded.

The existing rent price

The existing rent price for the 1st to 5th floors are AUD 7.17; AUD 6.51; AUD 5.75; AUD 4.72 and AUD 3.21 respectively. The finance regulation is similar to the other low-cost apartment managed by Local Government of Surabaya. The rent price is expected to be allocated for the operation and maintenance activities. But it is not significantly covered those costs. The annual total income from the rent price is described in Table 3.

Table 3. Income from the existing rent price.

	Rent price per unit (AUD)	Number of units	Expenditure (AUD)
2nd floor	6.51	24	156.24
3rd floor	5.75	24	138
4th floor	4.72	24	113.28
5th floor	3.21	24	77.04
			484.56
Annual income		12	5,815

The annual income from the existing rent price is AUD$ 5,815 (see Table 3), while the total cost AUD$ 78,048 (table 2). A significant gaps between income and cost need to be covered by local government subsidy. The local government has to subsidy

the gap between income and total cost, which is reached AUD$ 72,233 or 92.5%. The Figure 2 illustrates the amount of local government's subsidy.

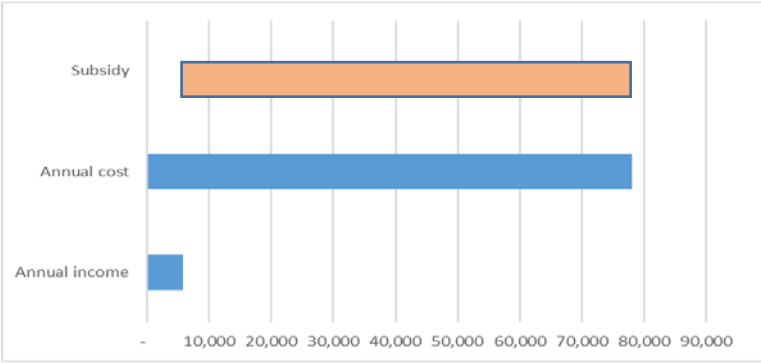

Figure 2. Annual government subsidy.

Figure 3 summarizes empirical results of the rent determination comparison based on the real operation and maintenance cost, tenants' ability to pay and the existing rent price. Minister of PUPR has suggested that the rent price determination should be less than 1/3 total income, which in this study is assumed as ability to pay. Overall, the result of rent price determination using the real cost is in accordance with the minister regulation.

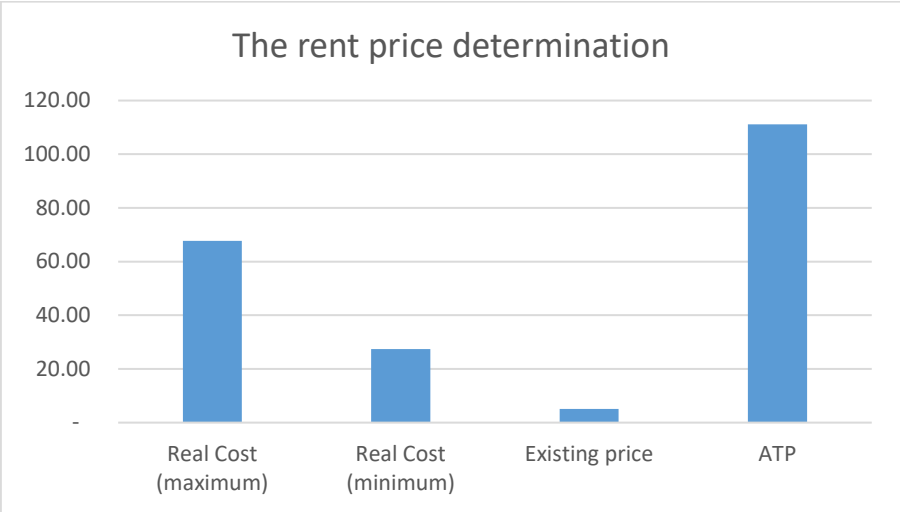

Figure 3. Rent determination comparison

The findings show the fact that basically, the low-income people are able to pay the low-cost apartment rental price regularly. The findings does seem like a contradiction between the affordability and the ability to pay. However, taking into account factors such as government subsidy the government subsidy that has allocated to the tenants. Generally, the Indonesian government allows the local government to subsidy to maximize the social welfare; however, the high government subsidy indicates the ineffective planning. Governments around the world utilize various types of subsidies in order to counter problems of housing shortages and affordability concerns (Wang, 2018; Yau et al, 2014). They suggest the role of government subsidy for any strategy to enhance the provisioning of affordable housing, therefore, government interventions

through financial and non-financial support as well as through policy reforms would be critical. Financial subsidies, subsidies in kind (e.g. in the form of government land) as well as cross-subsidies will have to play a central role in addressing the problem. However, it should counterweigh the decisions on subsidy level and rent determination, either a low subsidy level with a high rent price, or a high subsidy level with a low rent price. Therefore, the study recommends the evaluation of local government regulation is necessary to manage government subsidy and to retain more appropriate level of rent that still consider affordable for the tenants, such as:

1. Rising the rent price to be the minimum rent price
   The existing rent price is measured to be lower than minimum rent price. If it could be determined higher, the government subsidy would be decreased.
2. Tenancy management
   The low-cost apartment is occupied by various tenants with various occupations. Even some low-cost apartments are not occupied by low-income communities. It indicates that they have ability to pay higher than the existing price. As low-cost apartment is aimed for low-income people, there should be a robust classification of low-cost apartment tenant. The middle-income communities has to pay above the minimum rent price based on their ability to pay for the low-cost apartment, while the low-income is allowed to pay the minimum rent price. It may avoid the misdirected government subsidy as well as misdirected focus and target. Furthermore cross subsidy might be applied using this method.

CONCLUSIONS

This study aims to provide an affordability review of low-cost apartment in Surabaya. The robust evidence on ability to pay and the real cost as well as the existing cost shows how the rent price is determined and it should be evaluated to reduce government subsidy. The study examined the reality rent price, which is lower than the real operation and maintenance cost. Therefore, the rent price determination should be evaluated to provide the better service of operational and maintenance of the building. Firstly, the rent price could rise by at least cover the operation costs (minimum rent price). Secondly tenancy management reform is required to ensure that only the low-income people occupied the highly subsidise low-cost apartment.

REFERENCES

B Bakhtyar, A. Z., K Sopian, O Saadatian, S Moghimi. (2013). Quality Housing in Affordable Price for Malaysian Low Income. WSEAS TRANSACTIONS on *ENVIRONMENT and DEVELOPMENT*, *9*(2), 78-91.

Bing, L., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005). The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of Project Management*, *23*(1), 25-35. doi:https://doi.org/10.1016/j.ijproman.2004.04.006

Goh, A. T., & Yahaya, A. (2011). Public Low-Cost Housing In Malaysia: Case Studies On Ppr Low-Cost Flats In Kuala Lumpur. *Journal of Design and Built Environment*, *8*(1).

Governor of East Java Province Regulation no 75/2017 concerning the Regional Minimum Wage in East Java Province, Indonesia

Head of Surabaya Municipal Government Regulation no 37/2017 concerning Low-cost Apartment Rental Price in Surabaya

Indonesian Act no 20/2011 concerning Low-cost Apartment

Kisnarini, R. (2015). Functionality and Adaptability of Low Cost Apartment Space Design, A Case of Surabaya Indonesia. *PhD Thesis of TU/e the Netherlands. ITS Press., ISBN: 978-90-386-3908-6*.

Minister of Home Affairs Regulation no 19/2016 concerning Guidelines for Local Government Asset Management. Indonesia Ministry of Home Affairs

Minister of Public Works and Public Housing Regulation no 1/PRT/M/2018 concerning Development and Management Assistance of Indonesia Low-cost Apartment. Indonesia Ministry of Public Works and Public Housing

Ministry of Public Works and Public Housing.(2014). Strategis Planning, Directorate of low-cost apartment 2014-2019, Indonesian Ministry of Public Works and Public Housing

Ntengwe, F. W. (2004). The impact of consumer awareness of water sector issues on willingness to pay and cost recovery in Zambia. *Physics and Chemistry of the Earth, Parts A/B/C*, *29*(15), 1301-1308. doi:https://doi.org/10.1016/j.pce.2004.09.034

Rachmawati, F., Soemitro, R. A. A., Adi, T. J. W., & Susilawati, C. (2015). Low-cost Apartment Program Implementation in Surabaya Metropolitan Area. *Procedia Engineering*, *125*, 75-82. doi:https://doi.org/10.1016/j.proeng.2015.11.012

Statistic Bureau-East Java Province, 2016, https://jatim.bps.go.id/

Stone, M. E. (2006). What is housing affordability? The case for the residual income approach. *Housing Policy Debate*, *17*(1), 151-184. doi:10.1080/10511482.2006.9521564

Wang, F., Xiong, M., Niu, B., & Zhuo, X. (2018). Impact of government subsidy on BOT contract design: Price, demand, and concession period. Transportation research., 110, 137–159. doi:10.1016/j.trb.2018.02.006

Whittington, D. (2003). Municipal water pricing and tariff design: a reform agenda for South Asia. *Water Policy*, *5*(1), 61-76.

Wood, G., Ong, R., & Cigdem, M. (2014). *Housing affordability dynamics: new insights from the last decade*. Retrieved from Melbourne: :

Yau, Y., Lau, W., & Wing Ho, D. (2014). Principle of Selectivity in Housing Rehabilitation Subsidies: Case Study in Hong Kong. Journal of urban planning and development, 141(3), 05014019. doi:10.1061/(ASCE)

CHANGING DEMOGRAPHICS AND HOUSING TYPOLOGIES: ADDRESSING SOCIAL AND AFFORDABLE HOUSING IN AUSTRALIA

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Abstract
This paper will report on current Sustainable Built Environment National Research Centre (SBEnrc) research which aims to identify the strengths and weaknesses of various social procurement approaches for social and affordable community and private rental housing in Australia. To achieve this, the research team is investigating the three inter-related areas of demographics and typologies; social procurement; and funding and financing models. This paper will primarily discuss findings of the first of these three areas.

An important question being asked is: has the time come to rethink the traditional distinctions between elements of the housing continuum in order for governments and not-for-profits to better engage with the market and institutional investors? In doing this, and to ensure access to safe and secure housing when needed, we need to: (i) address the types of housing being provided across the spectrum; (ii) better understand the changing nature, needs and demographics of each cohort; and (iii) diversify our housing responses, seeking innovative and perhaps informal approaches providing housing which respond to the various needs of different cohorts.

Early findings around the demographic and typological theme are showing an aging population with complex life course trajectories including the multiple presentations of family that exist in a modern society, and longer stay of young adults in the parental home. Key emerging trends identified include: a more holistic approach to achieve resilient and sustainable communities and environments; inner-city infill is a priority area in large cities, with higher densities in bigger cities accommodating a broad variety of dwelling types; community engagement and input is increasingly considered as a valuable resource; and more resource efficient housing developments are needed and are becoming mandatory.

Keywords: Social housing, Affordable housing, Demographics, Housing typologies, Australia.

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INTRODUCTION

Current research is seeking to identify the strengths and weaknesses of various social procurement approaches for social and affordable community and private rental housing in Australia through investigating the three inter-related areas of demographics and typologies; social procurement; and funding and financing models. This will ultimately lead to the development of a set of social procurement criteria which address this changing and complex sector, to assist those responsible for both policy development, and asset and service delivery.

This research builds on the findings of two previous research projects, *Rethinking Social Housing*[1] and *Valuing Social Housing*[2]. That research provided the methodological underpinning including consideration of impacts across the nine domains of community, economy, education, employment, environment, health and wellbeing, housing, social, and urban amenity. It also established a productivity-based conceptual framework that highlighted productivity benefits from four angles: the individual; macroeconomic; fiscal; and non-economic such as social and environmental capital.

An important question raised in the course of this investigation is: has the time come to rethink the traditional distinctions between elements of the housing continuum in order for the government and not for profit sectors to better engage with the market and institutional investors? In doing this, and to ensure that safe and secure housing remains available to those in need, when they need it, we need to: (i) address the types of housing being provided across the spectrum; (ii) better understand the changing nature, needs and demographics of each cohort; and (iii) diversify our housing responses in Australia, seeking innovative and perhaps informal approaches providing housing which responds to the various needs of different cohorts.

This paper thus reports on early findings and conclusions with regards to the changing demographics and associated impact on housing typologies.

RESEARCH APPROACH

An initial review of both academic literature and industry documentation was undertaken in mid to late 2017, across the fields of demographics, housing and community typologies, social procurement approaches, and funding and financing models. This particularly included Australian Housing and Urban Research Institute (AHURI) academic publications and documentation from State agencies involved in the delivery social and affordable housing (with a particular focus on New South Wales (NSW), Queensland (QLD and Western Australia (WA). A limited review of international literature was also conducted from the United Kingdom (UK) (especially HACT UK), the European Network of Housing Researchers (ENHR), the Canadian Mortgage and Housing Corporation (CMHC), and the United Stated (US) National Housing Conference. Findings from the social procurement, and funding and financing streams of this research will be reported elsewhere.

DEMOGRAPHICS AND HOUSING TYPOLOGIES– A CRITICAL LINK FOR FUTURE SYSTEM RESILIENCE

This research is investigating the significant changes which have occurred, and will continue to occur, in Australian demographics, and that are thus impacting on the social and affordable housing sectors.

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[1] http://sbenrc.com.au/research-programs/1-31-rethinking-social-housing-effective-efficient-equitable-e3/

[2] http://sbenrc.com.au/research-programs/1-41/

The affordability crisis is evident in Australia due, in part, to the cost of housing that has outpaced minimum wages and pensions. Other influences are: the decline in local economic activity; the mismatch between population growth and insufficient supply of new housing; and out of date planning zoning and land-use regulations reducing land availability for the provision of affordable housing (Demographia 2017, AHURI 2017).

The main factors affecting the social and affordable housing sectors are the changing age-structure driven by population ageing (Cigdem et al.2015) and the increase of the number and diversity of households, compared to the rate of population growth (HILDA 2017). This is due to a detected increased complexity in life course trajectories including the multiple presentations of family that exist in a modern society and longer stay of young adults in the parental home because of rising unaffordability in housing markets. Therefore, there is a mismatch between the changing demographics of those in need and current housing stock that needs to be addressed, requiring more variety in the type of social and affordable housing available to vulnerable groups.

The research question guiding the investigation is 'how are the housing typologies changing or how do they need to change to face growing demands, demographic variations and sustainability issues?' This question led to an exploration of emerging demographic trends and responsive housing types and precincts, and how future needs will be met through consideration of more holistic approaches to achieve resilient and sustainable communities and built environments. Australian examples, especially those from WA, Qld and NSW along with international cases were analysed to propose housing typologies that can address needs across the spectrum, with a particular focus on the social and affordable community and private rental segments.

Demographics

According to the recent Household, Income and Labour Dynamics (HILDA) report (HILDA 2017), conducted from 2001-2015, household types have been relatively stable across the nation, with 41 per cent of the population living in *couple with dependent children households*; with 20 per cent being *couples without children* in second place. However, this survey detected other trends in household structures due to various factors such as population ageing, choices individuals make about living arrangements, preferred lifestyles and attitudes towards marriage, parenting and work. As a result, that study found some non-standard emerging household types such as *multi-family* and *single parents with non-depending children households* growing 4% and 1.4% respectively. The process of population ageing has a strong impact on households' composition as well. As population over 65 years is projected to double by 2030 (Cigdem et al 2015), the trend for households of *couples without children*, and *single-person* are also expected to grow in coming decades (HILDA 2017).

In terms of general population growth, Western Australia currently has a population of 2,623,164 (around 80% concentrated in Perth and Peel region) and an estimated growth to 3,500,000 by 2050. *Couples with children* is the most common household both in Perth and regional WA, followed by *Single person households* (ABS 2017; WAPC 2015a; HIFG 2017). Queensland has a population of 4,883,739 half of it concentrated in Greater Brisbane. Estimated growth 8,000,000 by 2050[3]. Most common household in Brisbane and regional Qld is *Couple with children*, followed by *Couple without children* (ABS 2017). And in NSW the population is 7,480,228, concentrating 4,823,991 in greater Sydney. Estimated growth 11,360,000 by 2050. Most common household in Sydney and regional NSW is *Couple with children*, followed by *Couple without children* (ABS 2017).

[3] http://www.qgso.qld.gov.au/products/tables/proj-pop-series-qld/index.php

According to the 2016 Census, the metropolitan areas of the three capital cities and regional areas of the three states do not present significant differences in terms of demographic cohort and household composition. The population median age is 36 years, presenting 5 per cent of older inhabitants (65+years), 7.5 per cent of people within 25 to 39 years (Millennials and GenY). Household composition is distributed between average 72 per cent of family households and 23 per cent of one-person households (38 per cent *couples without children*, 44 percent of *couples with children* and 15 per cent *of sole-parent families* (ABS 2018).

Of this, and considering demographic projections trends (HILDA 2017), key target cohorts for social and affordable housing will include elders, young people (Millennials, GenY), single-person and single parent households, which require diversity in housing options to suit changing lifestyles and market demands.

Typologies

The lack of affordable housing is impacting all age cohorts across the nation. From the 2016 Census statistics (ABS 2018), comparisons between dwelling composition, structure and tenure in Perth, Brisbane and Sydney show that in the three capitals, detached houses are dominant typologies (WA and Qld with average 78 per cent; NSW with 66 per cent). This is followed by semi-detached houses (WA with 14 per cent, NSW and Qld with average 11 per cent), and apartments (NSW 20 percent; Qld 11 per cent and WA 6 per cent).

The demographic trends explained in the previous section suggest the need to address innovative and affordable solutions incorporating the concept of sustainable communities, smaller units with access to green spaces, amenities and public transport. This was identified by the early review of academic and industry literature pointing to several relevant initiatives under development in the three states studied, along with lessons from international cases that can be adapted to Australian conditions.

In **Western Australia**, the Department of Communities (Housing) has developed and is implementing innovative housing strategies and typologies that are complemented by educational programs and incentives to sustain people within the housing system and also facilitate transitions across the housing continuum.

Social Housing initiatives include:

- *Social Housing Investment Package (SHIP)* - is part of the State Affordable Housing Strategy that supports transition though the housing continuum and aims to favour seniors and families with children on the priority waiting list through the provision of new dwellings (about 1,000 additional homes), purchase of spots and private rental leases.
- The *Rental Pathways Pilot* - assists eligible tenants to transition from public housing to private rental market and maintain a successful tenancy there.

Community housing initiatives include:

- *Sustainable Housing for Artists and Creatives (SHAC)* - developed and owned by community provided Access Housing (who also deliver other community housing options), won the 2017 UDIA (WA) award for Excellence in 'Leading Affordable Housing Development Project' category. SHAC comprises 12 apartments and two art and creative studios which offer residents strata community-based solar energy capture, storage and shared usage infrastructure. SHAC is part of the White Gum Valley (WGV) development in Fremantle (https://www.accesshousing.org.au/more-awards-success-for-access-housing).

Affordable private rental initiatives include:

- *White Gum Valley 'Innovation through demonstration"* - precinct in Fremantle, is a partnership of the City of Fremantle and Landcorp, WA's land authority. It offers a variety of new approaches, such as family and row houses and apartment studios, and a sector incorporating the Baugruppen approach. The same site is also home to the *Gen Y Demonstration Housing Project*, which consists of three interlocking one-bedroom apartments that appear as a single house (Landcorp 2017).
- *Connected Living* - aims to deliver more affordable developments around key transit precincts and activity centres. The WA Department of Communities, Housing set a target of 500 apartments, in seven sites in metropolitan Perth. The developments have to align with the objectives of affordability, diversity, design quality, and innovation.
- *Micro lots* – this initiative targets first home buyers and downsizers, offering a new housing typology consisting of villages of lots under 100sqm and homes of up to 120sqm, located close to public transport. The first community launched, in Ellenbrook is designed to house eight villages with an estimated population of 30,000. This is a public-private partnership between the Department of Communities and two private companies (WA Department of Communities 2018).
- *Tiny houses* - the City of Fremantle has supported an amendment to the WA planning scheme proposing the subdivision of larger residential blocks to create smaller independently-owned houses and encouraging the conversion of one single dwelling into multiple smaller dwellings within the existing built form (City of Fremantle 2017).

In **Queensland** social housing and community initiatives include:

- The *Queensland Housing Strategy 2017–2027* - aims to deliver more social and affordable housing and better services to people in need. The strategy targets growth, prosperity, connections and confidence, and is complemented with an *Action Plan* that provides key actions and deliverables for each category to drive key reforms and guide investment across the whole housing continuum (Qld Government 2017). Through an investment of $1.6 billion, the Strategy aims to provide 4,522 social homes and 1,034 affordable homes state-wide, generating 450 full-time jobs a year across 10 years. The Strategy also encompasses youth foyers to protect and house young people exiting institutional and out-of-home care encouraging education, training and employment opportunities to support their transition to independence (Qld Government, 2017).

Affordable private rental initiatives include:

- *The Density and Diversity Well Done Open Ideas Competition* initiative - encourages built environment designers to deliver innovative ideas for affordable housing and sustainable communities. This competition is based on that in NSW for the design of the 'missing middle', a term used to describe dwellings that are compatible with surrounding lower density resident environments, incorporating affordable and buildable projects (Qld Government, 2017).
- *Shaping SEQ* - builds on previous regional plans and has identified the missing middle as a range of housing types between the two extremes of detached houses and high-rise apartment buildings focusing on affordable living (https://www.qld.gov.au/about/newsroom/shaping-seq).

In **New South Wales** the Department of Families and Community Services, Communities Plus program, Land and Housing Corporation (LAHC) is delivering a new generation of integrated housing developments through government, private and non-government partnerships. 23,000 new and replacement social housing dwellings are being provided aiming for quality, integrated communities with improved social outcomes

(https://www.facs.nsw.gov.au/__data/assets/pdf_file/0003/425559/FACS-Land-and-Housing-Corporation-Statement-of-Business-2016-17.pdf).

To encourage affordable housing development which incorporates the needs and character of the surrounding area, the NSW Department of Planning and Environment created several planning policies to encourage the development of new affordable housing and the maintenance of existing stock. They include:

- *NSW State Environmental Planning Policy Number 65 – Design Quality of Residential Apartment Development (SEPP 65)* - this policy aims to increase the supply and diversity of affordable rental and social housing in the state. It covers housing types including: villas, townhouses and apartments, secondary dwellings (granny flats), new generation boarding houses, group homes, social housing, and supportive accommodation.
- *Planning initiative AHSEPP (2009)* - aims to increase the supply and diversity of affordable rental and social housing in the state.
- *Design Guide for Medium-density Housing* - is part of the NSW Government's commitment to facilitate faster housing approvals and deliver a diverse range of housing options to support NSW's changing demographics and affordability (http://www.planning.nsw.gov.au/Policy-and-Legislation/Housing/Medium-Density-Housing).
- *The Missing Middle Design Competition* - was instigated to put into practice the design principles for medium-density housing for NSW. This competition sought high-quality, innovative design solutions for low-rise medium-density housing, including detached and attached dual-occupancy dwellings, terraces and townhouses, to bridge the gap between inner-city high-rise apartments and low-density housing on the outer fringes (https://www.google.com/search?client=safari&rls=en&q=%22+The+Missing+Middle+Design+Competition&ie=UTF-8&oe=UTF-8).

  Integrated large scale projects delivering housing developments across all three categories-social, community and affordable rental include:
- *Ivanhoe Estate* - located on an 8.2-hectare site, Ivanhoe Estate envisions the transformation of 259 social housing properties into a socially integrated neighbourhood of around 3000 to 3500 properties including up to 1000 social and 128 affordable rental apartments, which means more people in need can move off the social housing waiting list. The project also will incorporate 120 bed residential aged care facility, 141 purpose-built social housing and 132 private independent living units, a wellbeing centre, educational facilities, public space and a retail centre (https://www.communitiesplus.com.au/major-sites/ivanhoe-1).
- *Western Sydney City Deal*, aims a measurable impact on the productivity, liveability and sustainability of the area, complementing NSW planning decisions to 2036 and influencing the state vision to 2056 (https://cities.infrastructure.gov.au/western-sydney-city-deal).

International examples, based on a limited review of the international literature, include the following examples of relevance to the Australian situation.

In **Canada**, *higher density residential developments* such of apartment condominiums, to accommodate to land high cost has attracted new households moving from rental housing, and people looking for urban lifestyles like downsizers and millennials. It also attracted developers making up roughly 50 per cent of new homes by 2006. *'Gentle density'*[4]and affordable housing options are being used to permit secondary

[4] http://www.smartergrowth.ca/what-gentle-density-and-why-do-we-need-it

suites (similar to Australian 'granny flats') and laneway housing in established neighbourhoods. Mid-rise housing also provides a less controversial, and more liveable, option. The *Housing affordability by design* initiative is about designing, building and renovating housing to be adaptable, durable, functional, resource-efficient and cost-effective. Well-designed typologies include: *Accessible housing* providing for the effective use of space to fit families with young children, older people and persons with disability; *Adaptable housing* aiming to fit changing needs in an affordable manner; and *Sustainable housing* including resource-efficiency, durable materials and easy maintenance (http://www.cbc.ca/news/technology/passive-house-affordable-housing-1.443233).

In the **United States**, Philadelphia provides a strong case for urban transformation. Current activity commenced in this city in 2005 to address the demands and needs of population growth and housing unaffordability. The success of this approach integrated key aspects including strong community participation in developing processes and decision making with: planning reform including the *Zoning Code* (Clarion Associates and Duncan Associates 2011); land use reform and the creation of the *Philadelphia Land Bank* and the *Philadelphia Land Bank Strategic Plan* (Philadelphia Land Bank 2017); developing significant projects based on *The Affordable Housing Design Competition* (PNDCCDC 2005); and considering sustainability as a priority. Many lessons, can be drawn from the Philadelphia case study, particularly for community involvement in participatory design and decision making, design initiatives and planning regulations for the regeneration of greyfields (as is the case of land use reforms and procurement such as the *Philadelphia Land Bank).*

In the **United Kingdom**, the government published a white paper titled *Fixing our broken Housing Marke*t in 2017. This provides a plan to boost the housing system, calling for community involvement and stakeholder integration. It includes measures to ensure: planning for the right homes in the right places; building homes faster; and diversification of the housing market. This strategy may provide lessons for the Australian environment (UK Government 2017).

Three **European community-led examples** are also worthy of note. These examples are demonstrating success in providing affordable housing through innovative approaches such as building communities and solving social problems at the same time (Davies et al, 2017). These are: the *Baugruppen* phenomenon in Germany (oriented to the affordable rental or purchase sector, mainly located in urban infills); social housing in Austria; and the *Living Laboratories* experimental approach in Sweden (oriented to affordable student accommodation).

Baugruppen (building groups) in **Germany** is a model of co-housing, which is architect-led and collectively funded by the future residents that allows them to act as their own developer in a multi-unit housing project. This strategy allows for reductions between 10 to 20 per cent in development costs. An important aspect of these developments is the connection with the urban context and the social interaction it promotes. It adds to urban vitality by incorporating mixed-use elements that fuel urban interaction considering social issues of inclusion and community, for example every Baugruppen project in Berlin has a shared garden, which is often open to the public (Ring 2016ww).

In **Austria**, Vienna's city government owns and manages about 25 per cent of the city's housing stock. In the 1980s, the city adopted a different approach aiming to collaborate with the private sector to build affordable housing rather than developing and owning more public housing. Thus, the city indirectly controls 200,000 units that are built and owned by limited-profit private providers, developed through a local government-

regulated process. This can be another case appropriate to Australian conditions. (*https://www.huduser.gov/portal/pdredge/pdr_edge_featd_article_011314.html*).

And in **Sweden**, the architectural firm Tengbom is constructing an apartment block to be occupied by students (*Living Labs*), located on the Chalmers University campus. The students will try different products, materials and test different ways of living. Research will be conducted in close collaboration with the Chalmers and Gothenburg Universities and the results will be used the Swedish Housing Cooperative (HSB) to develop innovative housing. Features include: flexible adaptable design enabling change layout over the ten-year duration of the experience; shared facilities such as an exhibition area, a common laundry room and a meeting area; cooperation between HSB and a management team with representatives from Chalmers, Interactive Institute and NASA (http://suslab.eu/partners/chalmers-th/hsb-living-lab/).

KEY FINDINGS TO DATE

Early findings from the demographic and typological research show an ageing population (estimated to double by 2030) with complex life course trajectories including changing family arrangements and longer stay of young adults in the parental home.

Several key emerging trends have been identified:

1) There is a need for a more holistic approach to achieve resilient and sustainable communities and environments to address affordability. These need long-term planning strategies, policies and processes where social and affordable housing is embedded in precincts with ready access to social services and facilities, public transport, amenities, and green open spaces. New housing types are also emerging in this context.
2) Inner-city infill is a priority area in capital and large cities, with higher densities in bigger cities that accommodate a broad variety of dwelling types. Such infill also potentially provides a more diverse selection of housing types, important to deliver a range of housing options suitable for social and affordable housing cohorts, in terms of both space and affordability. Tenure diversity is also an essential element in this equation to provide opportunities of mobility across the housing spectrum (Rowley et al 2017). Infill can provide a range of benefits to social and affordable housing sectors and also to affordable private market including: savings from consolidating existing infrastructure can contribute to the affordability of new developments; contributing to updating existing amenities and creating new ones; providing higher density to improve and expand public transport networks and services; and providing additional opportunities for quality design and improved sustainability of dwellings and precincts. (Rowley et al 2017).
3) Community engagement and input is increasingly considered as a valuable resource in identifying the needs of future owners or tenants, regarding diversity, flexibility and sustainability of new developments.
4) More resource efficient housing and developments are needed and becoming mandatory.

EARLY CONCLUSIONS

Key demographic changes are related to: (i) population growth, mainly due to longer life expectancy and to migration processes; and (ii) a trend toward one-person and multigenerational households, due to changes in family arrangements, such as longer stays of young adults in the parental home (often for financial or cultural reasons). These trends are altering household composition and affecting lifestyles and the demand for

appropriate housing. This is in turn impacting on social and affordable private rental cohorts, and thus affecting the capacity of governments and CHPs to address specific demands.

To address this changing environment, a review and adaptation of local planning systems and regulations is necessary (and in some cases is underway) to facilitate mechanisms that allow for higher densities and greater diversity of housing stock. Philadelphia is one example of how to address these affordability issues. Despite its population growth, that city invested in infill and existing housing stock renovation to accommodate migrants and local demand. The strategy included: community engagement in development and approvals processes; zoning code reforms that allowed to increase percentage of development built as-of-right; land use reform; and architectural competitions to create significant, memorable housing projects.

Many cities are currently revising and adapting planning laws and regulations to encourage construction of more multi-residential typologies for social and affordable housing. Local Governments are also streamlining regulatory and design review processes to reduce construction costs. Some countries already have developed land regulations and are proposing plans to achieve housing goals, as is the case of England, and from which lessons can be drawn to ameliorate the Australian system.

Another critical element is identifying and developing new housing typologies which address the changing demographic and economic environment confronting the housing sector. Australia's heritage of the detached house is changing, but still constrains our thinking.

A further key lesson to be drawn from successful national and international cases highlighted in this paper is the creation of sustainable communities as foundation for affordable housing. This approach facilitates decision-making and sustainable and resilient urban infill. A holistic approach to the design of these communities is crucial to ensure affordable living, through the inclusion of the cost of dwelling, transport, food and clothing and access to amenities, green space, schools and jobs in affordability analysis. Medium-density typologies with a variety of units allowing for multigenerational and diverse, inclusive social connections seem to be the most appropriate for the inner-city infill, not letting behind low-density single-family homes, but also combined with access to transport and amenities. Community input remains a valuable resource in decision-making and in identifying the real needs of future owners or tenants, regarding diversity, flexibility and sustainability of new developments.

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REFERENCES

Australian Bureau of Statistics (2018) 049.0 - Census of Population and Housing: Estimating homelessness, 2016. Available at http://www.abs.gov.au/ausstats/abs@.nsf/mf/2049.0 Accessed 25 March 2018

ABS 2016 Census Quick Stats. Retrieved 7 March 2018 from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC51218

Cigdem, M., Wood, G. and Ong, R. (2015). Australian demographic trends and their implications for housing subsidies, AHURI Positioning Paper No.164. Melbourne: Australian Housing and Urban Research Institute at RMIT University. Retrieved 20 April 2017 from http://www.ahuri.edu.au/publications/projects/p53039

City of Fremantle (30.11. 2017). The Freo Alternative - small housing. Available at https://www.fremantle.wa.gov.au/news-and-media/3112017-freo-alternative-–-small-housing

Household Income and Labour Dynamics in Australia (HILDA) Survey: Selected findings from waves 1 to 15 (2017). The 12th Annual Statistical Report of the HILDA Survey. Melbourne Institute: Applied economic and Social Research. Available at http://melbourneinstitute.unimelb.edu.au/hilda/publications/hilda-statistical-reports

Landcorp (2017). White Gum Valley. Available at http://www.landcorp.com.au/Residential/WhiteGumValley

Philadelphia Neighbourhood Development Collaborative and Community Design Collaborative-PNDCCDC (2005). The Affordable Housing Design Competition. Available at https://cdesignc.org/uploads/files/661989402500144183-affordable-infill-housing-design-challenge.pdf

Philadelphia Land Bank. 2017 Land Bank Strategic Plan. Available at http://wp.philadelphialandbank.org/wordpress/wp-content/uploads/2015/01/philadelphia-land-bank-strategic-plan-february-2017.pdf

Productivity Commission (2018). Report on Government Services, Chapter 18 Housing. Available at http://www.pc.gov.au/research/ongoing/repot-on-government-services/2017/housing-and-homelessness accessed 21 March 2018

Queensland Government, Department of Housing and Public Works (2017). Queensland Housing Strategy 2017-2027. Available at http://www.hpw.Qld.gov.au/housingstrategy/Documents/QldHousingStrategy.pdf

Ring, K. (2016). Reinventing density: How Baugruppen are pioneering the self-made city. Available at https://theconversation.com/reinventing-density-how-baugruppen-are-pioneering-the-self-made-city-66488

Rowley S, Ong R and James A (2017). *Perth's Infill Housing Future: Delivering Innovative and Sustainable Housing.* Curtin University, Perth

UK Government, Department of Communities and Local Government (2017) Our Broken Housing Market. White paper. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/590463/Fixing_our_broken_housing_market_-_accessible_version.pdf

Western Australian Department of Communities (Housing). Connected Living. Available at http://www.housing.wa.gov.au/investorsandpartners/socialhousinginvestmentpackage/Pages/default.aspx

Western Australian Planning Commission- WAPC (2015a). Towards Perth and Peel @3.5 million. Diverse City by Design Fact Sheets. Available at https://www.planning.wa.gov.au/publications/3.5million.aspx

Wood, G., Cigdem, M. and Ong, R. (2017). Australian demographic trends and implications for housing assistance programs, AHURI Final Report No. 286, Australian Housing and Urban Research Institute Limited, Melbourne, doi:10.18408/ahuri-5303901. Available at https://www.ahuri.edu.au/research/final-reports/286

CUSTOMER-ORIENTED APPROACHES TO HOUSING AFFORDABILITY IN INDUSTRIALISED HOUSE BUILDING

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Abstract
Prefabrication has long been considered as a means to lower the cost of house building globally, however the reality is often not as simple. Many factors affect its ability to achieve affordable housing solutions, such as uncertainty around what prefabrication actually is, what it should be, and the processes involved. Rather than a 'product first' solution, examining the process of industrialised house building (IHB) can offer a more integrated model.

This paper consists of a comparative case study analysis of two established IHB companies which utilise a customer oriented business model with the aim of increasing affordability in different contexts: Boklok in the multi-residential market in Sweden today; and Pettit and Sevitt in the single residential housing market in Australia 50 years ago. Despite their obvious differences in location, timeframe, social and cultural contexts, they are a useful (and novel) comparison as both originated from a customer, rather than product, driven model that addressed the prerequisites of specific users at a reduced housing cost to varying success.

This paper reflects on the barriers and best practices these companies encountered whilst aiming to achieve housing affordability whilst utilising IHB principles, and may provide a valuable source both internationally and in Australia.

Keywords: Housing Affordability; Industrialised House Building; Prefabrication.

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INTRODUCTION

Housing unaffordability in Australia has been a pressing issue in the media for some time now, with Sydney's median housing price reaching almost 13 times the median salary last year (Cox and Pavletich, 2018). The solution to this problem has been met with numerous proposals at the national and state planning levels through to individual grassroots developments (Rowley & Ong, 2012; Yates & Milligan, 2007), yet the availability of affordable housing continues to decline.

There have been several ways to define housing affordability in recent history, but the Australian Housing and Urban Research Institute (AHURI) provides a definition for Housing Affordability as *"a general term, used in reference to the whole housing system, expressing the relationship between housing costs (prices, mortgage payments or rents) and household incomes.*" This term can refer to both public and private housing, however it is more commonly associated with the private housing market and sale prices.

In addition to quantifiable indicators of housing affordability, like the cost of housing relative to income, a number of other factors affect the affordability of housing. The Grattan Institute's recent report (Daley, Coates & Wiltshire, 2018) on housing affordability also highlights a number of factors affecting the high cost of housing in Australian including: taxation settings which encourage homeownership and investment in housing, while discourage downsizing; economic growth, rising household incomes and access to credit; immigration; and shifts towards city centres; supply falling behind demand; not enough medium density supply; planning regulations limiting development; and social housing not adding to supply. Friedman (1992) also notes housing can be designed for affordability through both cost reduction, which affects the immediate quantitive aspect of affordability, or by value adding, which is a more qualitative and long term. The latter may affect how people live in their homes, adaptability and flexibility of the house, operational costs, sustainability, maintenance and future resale. These aspects, though less quantifiable, are just as important to tenants.

In the academic discourse on housing affordability, the majority of texts focus on two main areas: the history and future ability of policy makers, such as government bodies and planning authorities to moderate the pricing of housing; or on finance, investigating the effect of subsidies, interest rates, taxes and alternate financial models (see Daley, Coates & Wiltshire, 2018; Yates & Milligan, 2007; Rowley & Ong, 2012; etc). Design and construction seem to garner very little attention.

However, prefabricated construction bucks this trend, and has long been suggested as a means of achieving affordability through not only cost reduction, but also time reduction, improved quality and better sustainability. Many academic texts refer to the affordability of prefab including: Friedman and Cammalleri (2015) cover the idea of *Cost Reduction through Prefabrication*; Davies (2005) who talks to the "cheapness" of prefab in *The Prefabricated Home*; and Smith (2010) mentions the term "affordable" almost 60 times in *Prefab Architecture*. Industry reports like McKinsey also claim prefabricated methods could reduce housing costs by up to 16% (Woetzel et al, 2014).

Yet prefabrication alone hasn't solved the housing affordability either in Australia or internationally. This is due to a number of factors, but Steinhardt et al (2014) documented recommendations for the increased uptake of prefabricated housing in Australia, which included a number of principles outside of construction alone including marketing and consumer demand, transport and logistics, utilising labour availability, and more complete business models.

Housing affordability requires a more holistic approach: integrating aspects of supply and demand, finance and development models, government subsidies and policies, planning frameworks, sustainability, design and construction. Industrialised House

Building (IHB), provides a lens through which to view businesses which integrate aspects of planning, process, product, relationships and customer focus.

IHB is often used interchangeably with prefabrication in common discourse, however prefabrication is merely one part of a larger process. Burnham Kelly (1951) began to touch on the idea of IHB when discussing prefabrication as encompassing not just production but also management, design, procurement, and marketing. Kelly saw prefabrication as a holistic and integrated process encompassing all aspects

Today, Lessing's definition of Industrialised House Building is the most comprehensive, stating "*Industrialised house-building is a thoroughly developed building process with a well-suited organization for efficient management, preparation and control of the included activities, flows, resources and results for which highly developed components are used in order to create maximum customer value*." (Lessing, 2006, 93). This process integrates 8 aspects including the planning and control of processes, technical systems, prefabrication, long term relations, logistics, information and communication technology, reuse of experience and customer and market focus. It is this last point of customer-orientation which this paper uses as a starting point, exploring companies which have utilised a customer-oriented IHB model to achieve affordability.

In addition to the definition and processes above, Lessing and Brege (2015), recognised three phases involved in successful IHB models including: firstly, market research which identifies a customer and their needs; second, the product and platforms are developed to meet these requirements; and finally, the increase of predefined and prefabricated production while balancing investments with product volumes and customer value. The case studies presented in this paper have been broken down into these three phases, showcasing how the two companies have used their customer-oriented IHB processes in an attempt to create better housing affordability.

This paper begins to examine two companies which utilise these IHB practices, with a specific focus on customer-oriented approaches, to produce more affordable housing in alternative contexts. Much of this research so far has been completed on Swedish IHB Companies (Lessing, 2015, Brege et al, 2014, etc) as there is a greater concentration (and acceptance) of IHB companies in the Scandinavian region. For the purposes of this research, a comparative Australian company has been chosen to exhibit the potential of IHB outside of the Swedish perspective. The differing customer base and subsequent product offering of the two companies provides an interesting comparison as to how housing affordability practices are not limited to specific housing typologies or demographics.

METHODOLOGY

Research into IHB companies, and the strategies they employ in achieving housing affordability, is multi-faceted, covering areas like design, marketing, production, construction, and processes. This does not fit neatly into quantitive data collection methodologies, but instead requires a qualitative methodology.

A case study methodology was chosen as the most suitable, with the flexibility to interpret the diverse data collected. As Yin (2003) and Eisenhardt (1985) define case study methodology, this research began with an initial research question from which the case studies were chosen. This research question limited the companies which would fit into the case study, as they had to utilise IHB, have a customer-oriented approach, and include an aspect of housing affordability. Data for these case studies was collated from literature reviews, international fieldwork, observations, and contemporary and archival documentary materials.

CASE STUDY: BOKLOK, SWEDEN

Boklok is a multi-residential housing provider in Sweden, which is a joint venture between Ikea and Skanska, established in 1996 following a national decline in residential construction. The partnership between Ikea and Skanska was built upon the company's existing assets - Ikea brought brand culture and customer knowledge, which was complimented by Skanska's proven track record in home building. However, the company runs itself independently of both companies, often relying on the brand confidence and customer loyalty of Ikea rather than the more negative connotations associated with the predominantly concrete construction of Skanska.

Customer + Marketing

As a company Boklok have a strong strategic plan that is focused around their customer base, which was identified as a gap in the market. Boklok (2012) established that the market was lacking in dwelling for small households of 1-3 people, despite 75% of the households falling into this category. Lars Wild-Nordlund (2007), the managing director of Boklok for 6 years, noted that they began by asking the questions *"Who are we building for? How much will the people we are building for be able to pay?*

After identifying the target market (*1. Right Customer*) before any other works begin, Boklok noted the customer needs, desires and budget. From this detailed market research, a restrained product range is developed (*2. Right Product*). Once the product is defined, specific types of land are sourced to minimises time and money spent on planning and site works (*3. Right Land*). Next, the site must also be sustainable from a financial and social aspect, ensuring there is enough customer demand as well as infrastructure (*4. Right Project*). Only at this point does Boklok employ prefabrication techniques, making sure their industrialised factory processes are optimised to the design and customer needs (*5. Right Construction*). Finally, the product is marketed directly to the original customer in store (*6. Right Marketing)*. This is done in conjunction with Ikea, who already have an established brand identity and the facilities to sell the products (Lessing 2017).

This customer-oriented model gives a strong direction to the business, ensuring it doesn't focus purely on product, but has a more holistic view of the entire process from development through to construction. This process which stems from the customer needs, desires and budget, was a result of classical customer research investigating affordability, household typologies, location, and desires in a home. This also stretched to include post-occupancy evaluations which has in turn affected redesigns of the product.

Boklok also identified that these small households were usually key workers with restricted budgets, and priced their product accordingly working backwards from a typical income. This has since been re-evaluated, and now apartments are sold at 25% less than comparable housing within the same area. The apartments are sold in an Ikea store closest to the development, through a lottery system. Clients must provide their own financing as they would with any other apartment.

Affordability and the 25% target are non-negotiable for Ikea and is part of their ethos for Boklok. To ensure this affordability is retained, if an apartment is sold within 2 years of purchase, the owners can only sell for a 10% margin above the original sale price. Despite producing housing significantly below market rate, Boklok is the most profitable area of Skanska, and the practises employed within Boklok are beginning to be replicated throughout the whole business (Lessing 2017). This highlights the efficiencies of their process including targeting strong market research, industrialised construction and the lack of customisation in the project.

They have the third most satisfied customer of housing developers in Sweden and believe this is because customers know exactly what they are getting when they purchase

a Boklok home, with delivery always meets expectations. However, as market competition grows on the back of Boklok's success, the company would like to become more unique and push innovation in the affordable housing sector (Lessing 2017). The initial market research for Boklok targeted specific locations, which lead to the design of the 4 storey Flex apartment. As the market expands, Boklok are looking to increase the structural capacity and fire resistance of the modules to allow buildings to reach up to 6 storeys, making more urban sites viable.

Product + Platform Design

Boklok have a very restrained product family, which limits customisation and streamlines manufacturing processes. Changes to the design are only in the cladding and gable or pitched roof options, with the customer simply being able to choose which apartment size they require. Despite this lack of personalisation, the designs offered by Boklok were based on the previous customer research and Ikea's previous experience regarding lifestyle choices of customers. This lead to a product which was designed to have ample natural light and ventilation, as well as the use of open plan spaces and natural materials where possible.

Boklok currently offers three product ranges – the Flex Apartment system, the Radhus row house, and the Classic apartment design (which is in the process of being phased out). Most projects utilise the 'Flex' system which was designed to be adaptable to urban sites, reaching a maximum of 4 storeys. 'Flex' is produced using 4 different modules which make up 1, 2 and 3 bedroom units, as well as an additional vertical circulation module (see Figure 3). Each apartment consists of two or three modules and includes a full kitchen and large combined bathroom and laundry as well as ample storage. The main window is full height in the living area to give an open feeling to the space and connects through to the balcony, while the smaller window in the kitchen allows for cross ventilation in the open plan space.

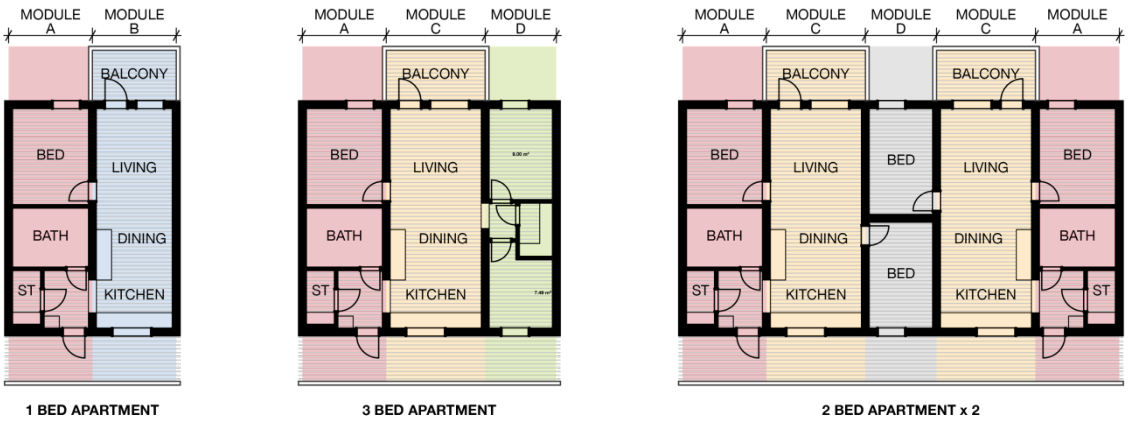

Figure 1: Boklok Flex apartment plans and module layout.

Every year Boklok has a review to update process, platform and product before they think about relaunching a new product. The benefits of their pure product family (fully mandated design with little to no customisation), is that more time can be spent on the design and development of the predefined product range, rather than repeated across a large range of designs. The company works with approximately 5 architects for new ideas in this design process, before selecting a single architect for their external facades and site layouts. All the documentation and detailing are completed in house by manufacturing engineers.

Procurement, Production and Construction

As a reflection of Boklok's low income client and subsequently standardised product, the company utilised an efficient and highly repeatable construction methodology. The volumetric prefabricated modules are constructed using building materials typical of buildings in the area, whilst utilising manufacturing processes to minimise time and waste. The modules are assembled using timber framed panels with rockwool insulation and plasterboard lining, similarly to typical housing construction in Sweden and most of the Western world, with all interior and exterior finishes being fitted out in the factory before transportation to site.

The production of these units is expected to top 2,000 modules per year by 2020, with most being completed by manufacturing works rather than those trained in construction. This is representative of the 'product' mentality and process employed at Boklok in their standardised offering.

Finally, sourcing land for the projects is a substantial part of ensuring the affordability of the overall development. Boklok employ at least 6 people who constantly work purely on land acquisition, to make sure there are no zoning issues and no excessive site works required for the land. As such Boklok do not hold any land and have a short turnover once purchased. Instead they ensure that the sites purchased require minimal preparation (mostly flat sites with good soil conditions) and those with simple planning rules.

CASE STUDY: PETTIT AND SEVITT, AUSTRALIA

The residential housing market in Australia underwent an organisational change in the 1950's and 1960's, as traditional builders were replaced by larger project housing companies. This made little change to the materiality of houses, but instead injected industrialised and manufacturing processes into the burgeoning market.

Pettit and Sevitt were one of the most well-known and enduring project house builders of the time. Established in 1961, the company rose from the ashes of SunLine Homes where its founders Brian Pettit and Ron Sevitt had worked in accounting and sales respectively. Pettit and Sevitt's enduring legacy comes not from their construction practises, but from the strong design ethos which pervaded their houses, as well as their marketing and brand.

Customer + Marketing

Unlike Boklok and their key-worker customer base, Pettit and Sevitt's targeted customer was a middle-class, young professional who Boyd notes as "*the sort of person who cannot afford an original painting, but buys a good reproduction, who cannot take a front seat at a concert but queues up for the gallery and keeps a record collection at home, who picks the good books from the lending library, the imaginative movies on the suburban circuit, and the well-designed items of kitchenware.*" (Boyd 1949, 84).

The company aimed to provide architect designed houses to the masses, making them affordable enough for the lower and middle classes, while retaining the aestheticism and functional planning of well-designed homes at the time. This was not only an aspirational aspect of their customer, but the culture of the time which commodified design and the inherent value it brought to architecture.

Originally the company worked on previous experience with customers from SunLine homes, but eventually commissioned market research on their customer base. The majority of these were young professionals, which mainly consisted of pilots, advertising people and architects (O'Callaghan, 2007). The needs of their customer

weren't just in the desire for good design, but in flexibility and personalisation of the houses. This meant the ability to adapt to specific sites, as well as the flexibility to cater to different lifestyles of their younger professional customer base. This was to become the reasoning behind much of the modularisation of floor plans in the Pettit and Sevitt Range.

Figure 2: Pettit and Sevitt advertisement in Australian Women's Weekly, Wednesday 2 July 1969, 45.

This idea of personalisation wasn't only evident in the design of the houses, instead it became the cornerstone of the Pettit and Sevitt Marketing campaign as well. Advertisements were targeted to 'The Different Australian', and individuality was emphasised firstly through the architect involvement in projects. Each house design was complimented with up to five standard variations as well as differing roof lines. Also, customers were also given carboard cut-outs which represented standard modular elements, allowing them to play around with designs to suit their whim, involving them in the design and customisation process.

The personal touch was carried further into the marketing strategy of the company, with the advent of the famous conversational advertisements. Like Figure 1, many print advertisements would feature discussions between Pettit and Sevitt in dialogue, presenting information without the hard sell. These became so successful, even in the advertising industry, the ads continued to run for years to come (even following the departure of Brian Pettit). The ads complimented the brand's identity as a front runner and innovator, and worked to create interest among customers rather than promote the housing designs. From the beginning, Pettit and Sevitt developed a highly organised marketing and management system which was continually refined. This is likely due to neither Pettit or Sevitt being builders, but having had extensive experience in the financial and marketing sectors of the project housing industry, and represented the 'culture of production' in the company.

Product + Platform Design

In McKay's review of contemporary Australian housing Pettit and Sevitt summarised how their market research affected their housing designs: *"The end result of our product development and marketing techniques is an economically priced house, designed by outstanding architects, that incorporates a built-in flexibility to cater for the needs dictated by the site, and the client, and a system that will allow the client to express his own personality"* (McKay et al, 1971, 128).

This flexibility to cater for the site was a key factor in Pettit and Sevitt homes. Though many were traditional flat floor plates, the Split Level and other designs like the curvilinear, were specifically designed for uneven terrain typical of the northern suburbs in Sydney. This allowed most homes to cater to a wide variety of sites, without extensive underpinning or changes to the plan which added additional costs to the home.

In addition to this site flexibility, Pettit and Sevitt had a range of seven to eleven basic houses, each with four or five standard variations that increased (or decreased) the size of the house, added additional bedrooms, or did a combination of both, in order to cater for a wide range of consumers. This also tried to ensure the "individuality" of the

houses and that customers felt like their home was designed specifically for their family (O'Callaghan, 2007).

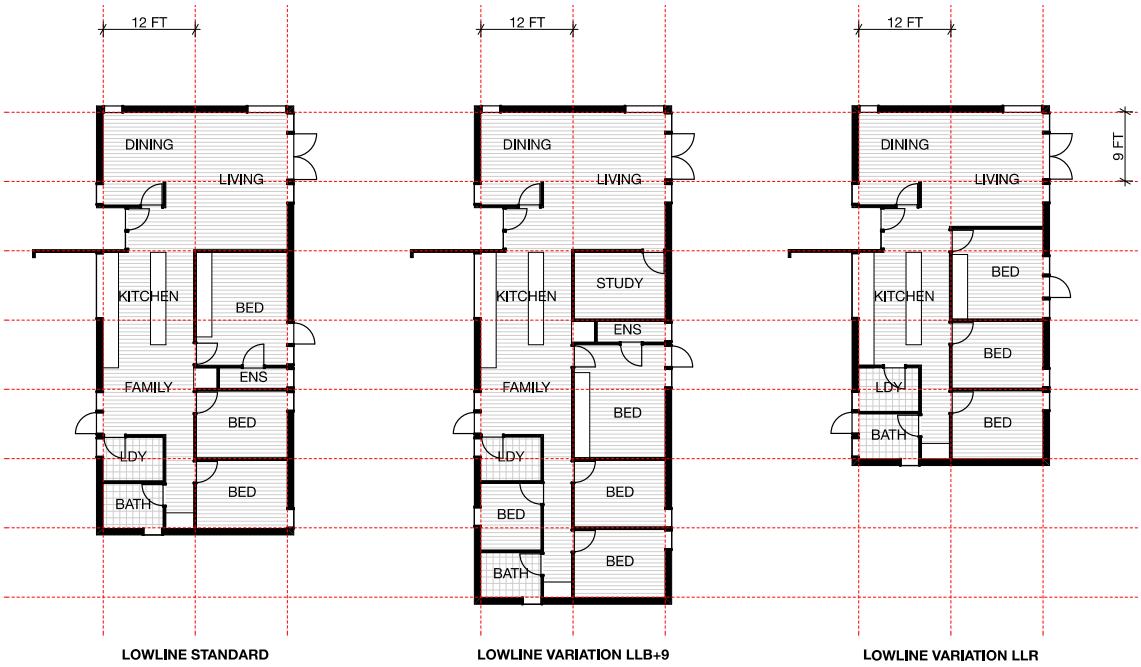

Figure 3. Lowline B standard plan with expanded and reduced variations.

Of all the houses the Split Level and the Lowline are the most well-known, each having had many iterations of similar designs, and were the only houses displayed at the first Pettit and Sevitt exhibition centre in Carlingford in 1963 (O'Callaghan, 2007). The Split Level went on to have 4 'Marks', of which the first one remained the largest and the final represented the smallest and cheapest of the designs at approximately 102sqm. However, the Lowline house is considered to be the most famous of the Pettit and Sevitt houses, with many still standing in Sydney, Canberra and the eastern coast of Australia today. In contrast to the Split Level, the Lowline was a flat-roofed, single-storey house, that was rectangular in plan with a linear progression from social, living areas to private bedrooms (see Figure 3).

Most importantly the Lowline encompassed many aspects of affordability, beyond just the price. The Lowline was described in 1964 as having "*outstanding design and detailing […] it combines economy in construction with full provision for both the practical needs of family living, and the emotional satisfactions people should get from the form and content of a house and its environment." (Wilson, 1964).*

Procurement, Production and Construction

Pettit & Sevitt incorporated a 'culture of production' into almost all aspects of their business, which they likely adopted from their time at SunLine homes which had "pioneered the commissioning, production and marketing of architect-designed project homes in Sydney" (O'Callaghan, 2007). From the marketing strategy through to the administrative operations and the construction, the company represented itself in much the same way as a commercial manufacturer - employing industrialised building methods, though on a much smaller scale than what we may consider as IHB today.

Eichler and Kaplan (1967) noted this involvement of manufacturing and marketing, outlining the role of the merchant builder, in contrast to other types of builders, included

a “rapid turnover of a product which he manufactures and merchandise to the consumers.” Woolley, the architect on many of the designs, notes that “with the advent of merchant building, the house has become a ‘product’ in the same sense as other manufactured items, such as washing machines and motor cars” (Woolley, 1967, 12), and it was in this way Pettit and Sevitt chose to portray themselves.

Quality product was key for Pettit and Sevitt, which was reflected in their construction process including streamlining the “production drawings and increasing the range of details… to achieve a high degree of faithful reproduction of the prototype houses” (McKay et al, 1971, 128). Part of this industrialised building process, was the semi-prefabrication and logistics utilised to build the houses. Timber frames were produced offsite en masse, and many processes were integrated rather than sequenced to shorten timeframes. Pettit and Sevitt felt that by using these mass production techniques, they could pass on benefits to the customer, allowing them to afford an architect designed house (McKay et al, 1971).

DISCUSSION ON AFFORDABILITY

The affordability of these two projects is intrinsically linked to both the targeted customer even though the housing products are vastly different, one being a low cost high density apartment model and the other being a mid-range detached dwelling. Both companies utilised IHB processes and an ‘outside-in’ business model to provide more affordable housing options within their specified market.

The affordability of Boklok is fundamentally tied with their desired customer. Focusing on the budget of a single teacher (or nurse depending on the narrative) with a child gives the product a very restrictive budget. At the time Boklok formed this was about SEK3,000/month (about SEK3,820 today, or $AU590), which would go directly to housing costs. However, during an observational trip to the Boklok headquarters in Malmo, this narrative no longer seems to be directly applicable. Instead, to retain the affordability of housing and the profitability of the company, all apartments are sold at 25% below market rate for similar dwellings in the area. This is still an ambitious and admirable affordability goal, which many affordable housing companies struggle to meet.

In addition to the costs benefits of the Boklok housing product, it is also known for its quality and sustainability. On average the Flex apartments are 30% more energy efficient than Swedish housing requirements according to Skanska, and are built using sustainable materials wherever possible including their timber framed construction.

Pettit and Sevitt houses are commonly referred to as solution for contemporary affordability issues in the media (Greenwood, 1999; Lacey, 2004; Farrelly, 2005; and Edgar, 2016), however as discussed previously, they have always held a specific place in the market. This is described, though sometimes contested, by Pickett in writing that Pettit and Sevitt’s housing was “*neither small nor particularly cheap… An expression of upmarket taste, this was architecture in its traditional role, increasingly confined to Sydney’s North Shore* (Pickett, 1997, 104).” However, in his 1987 thesis, Temple notes that it was estimated a Pettit and Sevitt house was 30% cheaper to build than a comparable architect-designed house. Very little data exists to back this claim, instead Buhrich contextualises the affordability of Pettit and Sevitt houses in a Sydney Morning Herald article in 1968 stating “*two-thirds of all home buyers in NSW spend less than $10,000 on their homes and it is for this market that the latest Pettit-Sevitt house […] has been designed*.” Buhrich goes on to conclude that responding to site conditions would usually add an additional 10% to the housing cost and that “*this house (or any other offered for just under $10,000) is still out of reach of very many home buyers*.” (Buhrich, 1968). It wasn’t until the beginning of 1970, when Pettit and Sevitt began to extend the lower end

of their offerings with the 3136. The small house was first advertised in the Sydney Morning Herald at $8,790, within the $10,000 budget of many home dwellers.

Pettit and Sevitt have stood the test of time in regards to their sustainability goals. Each house was designed with large windows to the north, shallow plans for cross ventilation, and large eaves to protect against the harsh sun. The passive solar aspects are complimented by efficient plans and the intangible aspect of design value which still has value today (see Greenwood, 1999; Lacey, 2004; Farrelly, 2005; and Edgar, 2016).

CONCLUSION

Boklok and Pettit and Sevitt are two case studies which are vastly different: in contexts, typologies and markets. However, both a customer-oriented approach to tailor their product to an identified gap in market needs, while efficiency utilising industrialised building methods to achieve a level of affordability for their specified customer. It is this customer and the business strategy which pervades their entire business: from the personalised approaches of Pettit and Sevitt in their marketing, construction methods, and design which reflect that of their aspiring, middle class customer; to the pragmatic and efficient highly prefabricated and standardised product for a lower income customer.

However, it can be argued this IHB and affordability methodology goes beyond the income class of the customer in both of these companies, and reflects the national culture in their respective countries. Swedish culture is known for their concept of *lagom* or 'just enough' and Isenhour (2010) notes this concept moderates consumption within the Swedish culture, but also embodies the "personal connections Swedes feel with nature." This can be seen in Boklok's use of 'natural' timber construction as well as the restraint in the design and fittings which are 'just enough' for a key worker to live a comfortable lifestyle. In comparison Australia, much like America, has a culture of aspiration, at the pinnacle of which is home ownership not only for the middle class but also the working class (Dyrenfurth, 2005). Pettit and Sevitt engaged with these aspirations allowing the middle class to achieve a house worthy of their new found financial security.

It is likely this strong customer, and nationalistic, focus which pervaded the industrialised house building processes of marketing, design, and production of both businesses contributed to their success. It could also be noted the integration and cohesion of all these areas is what allowed the companies to provide a quality, responsive product at a competitive price, and today both companies have an enduring brand legacy which is built from this strong market research.

REFERENCES

Boklok AB. (2012). *The Boklok Story.* Retrieved www.boklok.com/upload/Documents /Downloads/Downloads_EN/The%20BoKlok%20story,%20fact%20sheet.pdf

Boyd, R. (1949) "Reach-Me-Down-Architecture," *Architecture,* 37(3), 84.

Brege, S., Stehn, L. and Nord, T. (2014), "Business models in industrialized building of multi-storey houses", *Construction Management and Economics*, 32(1/2), 208-226.

Buhrich, E. (1968, March 19) "A Split-Level House for Less than $10,000." *Sydney Morning Herald,* 19 March 1968, 18.

Cox, W. and Pavletich, H. (2018). *14th Annual Demographia International Housing Affordability Survey.* Belleville IL, USA: Deomgraphia.

Daley, J., Coates, B., and Wiltshire, T. (2018). *Housing Affordability: re-imagining the Australian dream.* Melbourne: Grattan Institute.

Davies, C. (2005). *The Prefabricated Home*. London: Reaktion.

Dyrenfurth, N. (2005). The language of australian citizenship. *Australian Journal of Political Science, 40*(1), 87-109.

Edgar, R. (2016, November 4). 1960s housing clusters offer a model for our times. *Sydney Morning Herald.* Retreived from www.smh.com.au

Eichler, E. P. and Kaplan, M. (1967). *The Community Builders.* Los Angeles: University of California Press.

Eisenhardt, K. (1989). "Building theories from case study research." *The Academy of Management Review*, 14(4), 532-550.

Farrelly, E. (2005, December 31). Shoebox or Gingerbread House? *Sydney Morning Herald.* Retreived from www.smh.com.au

Friedman, A. (1992). *Design for growth and adaptability in affordable housing*. Montreal: Affordable Homes Program, School of Architecture, McGill University.

Friedman, A. and Cammalleri, V. (2015). "Cost Reduction Through Prefabrication: A Design Approach." *Housing and Society*, 24(1), 1-14.

Greenwood, H. (1999, September 9). Home Delivered. *Domain* supplement, *Sydney Morning Herald.* Retrieved from http://www.proquest.com

Isenhour, C. (2010). "Building sustainable societies: A Swedish case study on the limits of reflexive modernization." *American Ethnologist*, 37(3), 511-525.

Kelly, B. (1951). *The Prefabrication of Houses*. Technology Press of the Massachusetts Institute of Technology and John Wiley.

Lacey, S. (2004, March 20). Don's Palace. *Domain* supplement, *Sydney Morning Herald.* Retrieved from http://www.proquest.com

Lessing, J. (2006). *Industrialised House-Building: Concept and Processes.* (Licentiate Thesis, Lund University, Sweden).

Lessing, J. and Brege, S. (2015). "Business models for product-oriented house-building companies." *Construction Innovation*, 15(4), 449-472.

Lessing, J. (2017). *Boklok and Industrialised House Building.* Presentation, Malmö.

McKay, I. et al. (1971). *Living and Partly Living.* Melbourne: Thomas Nelson.

O'Callaghan, J. (2007). *Project Housing and the Architectural Profession in Sydney in the 1960's.* (Doctoral Thesis, University of New South Wales, Australia).

Pickett, C. (1997). *The Fibro Frontier: A Different History of Australian Architecture*. Sydney, Australia: Powerhouse Publishing.

Rowley, S. and Ong, R. (2012) *Housing affordability, housing stress and household wellbeing in Australia*. AHURI Final Report No.192. Melbourne: Australian Housing and Urban Research Institute.

Smith, R. (2010). *Prefab Architecture: A guide to modular design and construction.* Hoboken, N.J: John Wiley & Sons.

Steinhardt, D. A., Manley, K. and Miller, W. (2014). *What's driving the uptake of pre-fabricated housing in Australia?* Brisbane: Queensland University of Technology.

Temple, J. J. (1987). *Pettit + Sevitt: The Significance of Pettit and Sevitt project Houses.* (Dissertation, University of New South Wales, Australia).

Wild-Norlund, L. (2007). BoKlok - IKEA and Skanska building for the future. *Proceedings of 13th Internationales Holzbau-Forum,* Bern, Switzerland.

Wilson, E. (1964). 'New Ideas in Sydney Projects: Pettit, Sevitt & Partners.' *AHB,* May.

Woetzel, J., Ram, S., Mischke, J., and Garemo, N. (2014). *A blueprint for addressing the global affordable housing challenge*. Seoul: McKinsey Global Institute.

Woolley, K. (1967) "The Architect's Role in Merchant Building," *Building Ideas,* 3(6).

Yates, J. and Milligan, V. (2007) *Housing affordability: a 21st century problem*. Final Report No. 105. Melbourne: Australian Housing and Urban Research Institute.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, Calif: Sage Publications.

THE IMPACT OF AIRBNB ON HOUSING MARKETS

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Abstract
Airbnb has been made possible by advances in technology and instant and ubiquitous access to the internet through handheld devices. Its arrival in 2008 resulted in a rapidly growing form of disruptive innovation within the traditional residential property and travel accommodation systems. Whether measured by Airbnb's valuation of US$31 billion (Thomas 2017), or the number of worldwide listings advertised (four million over 191 countries (Airbnb 2017b, p.203)), it is clear Airbnb is a significant and growing phenomenon, with the potential to reshape cities around the globe, both socially, economically and especially with regards to housing markets. Airbnb is likely to have multiple, complex impacts that reflect how this new phenomenon interacts with established businesses, places, cultures, tourism industries, and how it alters the ways in which housing is used and viewed. Airbnb's development is not limited to the confines of the share or collaborative economy. Rather, this research explores how Airbnb is a disruptive innovation that further commodifies housing and therefore, has the potential to disrupt not only accommodation services, but conventional notions of housing and home.

Keywords: Housing affordability; Disruption; Airbnb; Private rental sector.

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INTRODUCTION

Airbnb was established in 2008 in San Francisco as an internet-based platform and smart device application, advertising short term rental accommodation. Early on this accommodation was largely shared accommodation, with 'hosts' listing a spare room or bed within their home for 'guests' to rent via the platform. The founders launched the initial platform with three air mattresses advertised on a blog site (Gallagher 2017). Today Airbnb has grown significantly, with a large number of whole home or apartment properties available, permitting a diverse range of accommodation types. Properties listed on the site vary from shared rooms, private rooms, granny flats (detached units), whole homes or apartments. The accommodation advertised ranges from standard urban accommodation to unique properties such as castles. Airbnb has grown significantly and now boasts global bed availability rivalling hotel chains (Gurran 2017). Airbnb, however, does not itself own any of these beds.[1] Instead home owners (but not always) advertise a bed or dwelling they have available for rent on selected days or full time. In 2016 Airbnb expanded further into the tourism sector with *Trips*, a new way for travellers to connect with locals on the platform and take part in local *Experiences (Airbnb 2016a).* While Airbnb is not the first short term accommodation platform, it is recognised to be the most dominant (Wachsmuth et al. 2017) and disruptive, particularly in terms of the options it offers and the global impact it has exerted (Gurran & Bramley 2017; Lee 2016). Other similar platforms which predate Airbnb include Stayz, HomeAway, and other informal short-term accommodation including, couch surfing, home shares, hostels and boarding houses.

This paper seeks to examine this relationship between Airbnb and the housing, particularly the private rental market in Australia at the conceptual level. This paper forms part of wider research using the impact of Airbnb on housing and government action or inaction as an example of Brenner's New State Spaces framework to 'decipher the transformation of statehood under contemporary capitalism' (Brenner 2004, p.1). The first section of this paper will introduce Airbnb and provide a review of the current literature and government responses to Airbnb. The second part of this paper will provide background to the context of Australia's housing market before beginning to examine the relationship between Airbnb and the private rental market, including how it may be contributing to the discussion as to how Airbnb is interacting with the private rental market.

AIRBNB

Airbnb has had an array of labels attached to it including the share or collaborative economy. Botsman and Rogers (2010), were among the first to conceptualise this business behaviour as a new form of share or collaborative economy. While the founders of Airbnb choose to associate with the share economy (Gallagher 2017), Airbnb's development is not limited to the confines of the share or collaborative economy. Internationally, Airbnb has received much attention from communities concerned of its impact (*Share Better* 2014; *Neighbours Not Strangers* 2016), as well as the reported economic benefits brought to communities by Airbnb (Harrison 2017; O'Mahony, Simes & Smirl 2017). Thus, far decisions have been made mostly at the city or local government level in Barcelona, New York and San Francisco. In both Barcelona and San Francisco registration systems have been put in place to monitor listings on Airbnb and other like STRA platforms where relevant. In Barcelona the key reasons given to restricting the

[1] This is expected to change with Airbnb's partnership with Niido to develop apartment buildings 'optimized for home-sharing' Airbnb 2017a, Airbnb, Niido to Partner to Support Home Sharing in Apartments

further growth of Airbnb were to reduce the pressures of tourism, guarantee the right to housing for local residents and ensure there is a balance between tourism activities and other economic activities (Barcelona City Government 2017). The San Francisco government established also established a registration system fought for the ability to fine Airbnb (and also HomeAway) themselves for illegal listings. To enable this process potential Airbnb listings can register their property with the San Francisco Government via the Airbnb website, during the Airbnb listing process. The San Francisco City Attorney has also described this as being to 'help prevent our [San Francisco's] precious housing stock from being illegally turned into de facto hotels as we work hard to turn the tide on San Francisco's housing crisis' (City Attorney of San Francisco 2017).

In Australia, Airbnb has become a household name and an accepted form of short term rental accommodation (STRA) or short-term holiday letting (STHL). This demonstrates the significant mark it has had on the way Australians travel and use their homes. Airbnb however, remains a largely undeclared and informal aspect of tourism in Australia (Tourism Research Australia 2017, p.13), despite tourism in Australia accounting for 12% of Australia's businesses, and $53 billion of GDP (Tourism Research Australia 2017, p.5). As reported by Airbnb, Australians are among the top ten users of Airbnb globally, as both guests and hosts. Sydney is among the top ten Airbnb destinations globally. In Melbourne, the suburb of Fitzroy alone increased its visits of Airbnb guests by 770% from 2015-2016 (Airbnb 2017b). Furthermore, Airbnb announced partnerships with Qantas, through its frequent flyer program (2016b) and the Flight Centre Travel Group as part of its expansion into business travel (2017c). More recently Airbnb also partnered with the Gold Coast as an official accommodation provider during the 2018 Commonwealth Games (Airbnb 2018). Airbnb's partnership with these major entities in Australian travel is likely to add to the legitimacy and reach of Airbnb, especially amongst those not naturally inclined to participate in the new economy.

Airbnb thought widely accepted in Australia, it has received some resistance and cause for concern in a number of areas, including, tax law, disruption to communities, tourism, planning and housing. In 2016 an inquiry into the adequacy of the regulation of STHL in NSW was published (NSW Government 2016). The first finding of this report was that the lack of a 'consistent state-wide definition of short term rental accommodation is a serious regulatory shortcoming' (NSW Government 2016, p.14). This inquiry found a low level of complaints, particularly on how STHL impacted communities in apartment and strata complexes. These complaints where, however, regarded as 'real and serious' for those affected (NSW Government 2016, p.viii). Since the completion of the report, an options paper was released for public consultation (NSW Government 2017). The options paper included a number of policy alternatives such as industry self-regulation, strata regulation, planning regulation and registration (NSW Government 2017, p.6) in order to manage the impacts of 'noise, waste, traffic and parking, safety and security, and the potential impact on housing and broader industry' (NSW Government 2017, p.4).[2] To date, only the NSW Government has formally considered the impact of Airbnb on housing. In Victoria, efforts to respond to Airbnb, thus far have been restricted to addressing the impact on the community, and this has been undertaken through the Owner's Corporations Amendment (Short-Stay Accommodation) Bill 2016, housing affordability was not considered. In South Australia the former Labour Premier supported Airbnb (Rau 2016b, 2016a) and hosted events to encourage the 'share economy'.

[2] Submissions to the Options Paper are now closed for consideration and can be viewed on the NSW Planning and Environment website (NSW Government 2018)

HOUSING IN AUSTRALIA – AFFORDABILITY & THE PRIVATE RENTAL MARKET

Housing in Australia has been a complex issue and growing concern, even prior to considering the impact of Airbnb. As Paris described, 'Housing is both a social need and a source of investment profit, and hence housing policy generates conflict, political debate and interest mobilisation' (1993, p.14). Australia has a long culture surrounding owner occupation of housing as a source of identity and investment (Beer, et al. 2011; Paris 1993). More recently this culture of home ownership has been questioned as land has become less affordable and renting more common, particularly for low income earners and young people needing to find accommodation (Beer, Kearins & Pieters 2007). This section explores some of the issues surrounding housing affordability in Australia, with a specific focus on the private rental sector or private rental market. An area which has likely received an additional source of demand as a result of the popularisation of short term rental accommodation, through platforms such as Airbnb.

Sydney's housing prices are among the highest in the world with the median housing price rising significantly from $600,000 to $900,0000 from 2013 to 2015 (Gurran & Phibbs 2017, p.83). Additionally, in recent years there has been growth in dependence on the Australian private rental sector (Hulse et al. 2012; Morris, Hulse & Pawson 2017), a reduction in lower priced housing stock (Gurran & Phibbs 2017) and a residual social housing stock under increasing stress (Paris 1993; Stephens 2017). These factors contribute to an increasing housing need in Australia. The Australian Housing and Urban Research Institute (AHURI) estimates almost 373,000 households in NSW are in housing need and this figure is expected to rise to 687,000 in 2025 (Rowley et al. 2017, p.1). In Victoria, housing need is expected to increase from 291,000 to 462,000 by 2025 (Rowley et al. 2017, p.1). Despite this, research has shown that Australia's public housing and affordable housing industry, as a whole, is not at a standard to meet the current or future housing need (AHURI 2017). From 1991 to 2016 ABS Census data reports show a change in the make-up of Australian housing. The number of households occupying private rentals grew from 26.9% to 30.9%, with the number of occupation of homes with a mortgage climbing from 27.5-34.5% and the number of homes occupied and owned outright reducing from 41.1% to 31.0%. (ABS 2017b). This is a contrast to the reduction of the private rental sector stock in the 1950s in response to increasing home ownership and public housing stock (Paris 1993, p.178). Research also predicts that private rental occupation and will continue to climb while owner occupation will fall as the private rental market becomes the predominant form of housing rather than as a transitional form (Hulse et al. 2018, p.9).

When viewed simply the affordability of the housing market can be viewed through a supply and demand equation. There are however, a number of factors that contribute to the supply and demand and also the type of housing supplied or in demand, which vary in urban and regional areas. These include the supply and cost of land, the planning process, exclusivity of urban suburbs of high status, the capitalisation of private and public investment into housing and the relationship between housing and employment (Badcock & Beer 2000, p.31). Furthermore, some research has shown that some property markets are more 'excitable' than others, including Sydney (Valadkhani & Smyth 2017), or that timing and one's position within the market is most crucial (Badcock & Beer 2000). There has been an increasing reliance on the private rental sector is a result of several factors, including the shift towards young Australian's desiring to live in more flexible arrangements, but also to live in housing that allows for flexible entry into an increasingly competitive labour market, which is often located nearby the CBD and which is suitable financially for those without a long term secure income (Hulse & Burke 2015,

p.140). In Australia the private rental sector refers to occupied properties in private ownership, either by individuals or companies that are rented out at market rates, directly by a non-resident owner/landlord or through an intermediary property manager/real estate agent (Pawson, Hulse & Morris 2017, p.1067).

In Australia, there are a number of factors which have contributed to the change in affordability of housing. Together these factors have resulted in a growing imbalance between social housing, affordable housing and private rental accommodation, in a housing system which is not equipped for sustainable private renting. The Australian housing system that has been structured towards providing housing for owner occupation consumption, rather than owner occupation as just one form of consumption, among others (Badcock & Beer 2000, p.13). This has occurred through preferential treatment of tax law towards home ownership and investors in the private rental sector, and contributed a 'class of people concerned with property rights at the expense of tenants' rights' (Hulse & Burke 2015). Additionally, weak tenant legislation in Australia for the private rental sector has been slow to reform. While, typical of liberal welfare regimes described by Esping-Anderson (Pawson, Hulse & Morris 2017, p.1064), Australia has fallen behind in reform (Hulse & Burke 2015, p.147), particularly since the global financial crises (Pawson, Hulse & Morris 2017). Another feature of the Australian private rental market is that majority of the private rental market is owned by owners with a small real estate portfolio, meaning they are likely motivated by capital gains rather than long term investment (Pawson, Hulse & Morris 2017, p.1067).[3]

HOUSING AND AIRBNB

The impact of Airbnb on the housing market can be considered in a number of ways. This next section provides just a few examples of impact Airbnb may have in Australian housing markets, with a focus towards rental markets. Other key factors surrounding housing affordability also related to the influence of the arrival of Airbnb to be addressed in future research include the relationship between housing markets and tourism (Dredge & Jamal 2013), second homes (Paris 2014; Paris & Thredgold 2014) and the need for appropriate and affordable density living in Australia's capital cities (CEDA 2017; Easthope, Troy & Crommelin 2017).

In Australia over the last 26 years, the number of bedrooms in housing has outnumbered the residents within the home (ABS 2017a; Allen, Reimondos & Gray 2012), making Australian homes (along with the rest of the developed world) a potentially very significant resource for Airbnb and comparable platforms. Often these rooms have been used as home offices, playrooms or a spare bedroom, but Airbnb offers an income generating alternative to these uses. This idea of bedrooms or vacant rooms within homes and the broader notion of what housing means in Australia will be explored further in future research. While there may be some positive economic results of the 'house sharing' promoted by Airbnb, Airbnb's claims that it makes a significant contribution to generating tourism income and helping owners pay their bills (Airbnb 2014), may not be accurate. Gurran and Bramley (2017, pp.89-90) report that this may only be relevant to a small number of homeowners who have a home that is 'appealable to the online accommodation market place' and in an appropriate location. Of the small number who are deriving an income from an Airbnb listing, the income received ranges from 10-19% of median rents and mortgage costs. In the long term such gains may not last, especially if they are capitalised into housing prices (Gurran & Bramley 2017, p.90). The conversion

[3] Two million rental properties, are owned by approximately 1.3 million households shown in data from 2009-2010 Pawson, H, Hulse, K & Morris, A 2017[3]. Where one or more people within the household own a private rental.

of a room into a single room for rent or shared room for rent on Airbnb means that this may be a room that is not available for rent as accommodation for a low income earner, such as a student.

The options paper from the NSW Inquiry into STHL noted that 'the continued growth of STHL is occurring at the same time as the housing market is generally becoming less affordable' and that 'some consider that STHL has the potential to compete against traditional forms of residential tenancy' (NSW Government 2017, p.12). Other research based on Airbnb and housing markets in the United States show that Airbnb had the largest impact on markets which have a lower percentage of owner-occupancy (Barron, Kung & Proserpio 2017, p.5). This is concerning for Australian housing markets as the private rental sector becomes a greater source of housing in capital cities, such as Sydney where Airbnb is a popular form of accommodation. The Australian private rental sector is characterised by small portfolio or 'mum' and dad' investors motivated by short term capital gains as opposed to long term investment, meaning Airbnb is appealing and likely to have a significant impact on the supply in the private rental market, as investors seek the flexibility of short term renting with potentially higher returns. For example in Sydney 61.5% of frequently listed and frequently booked properties on Airbnb are whole homes/dwellings, that is a total of 20, 176 whole dwelling listings (Cox 2017)[4]. That is over 20,000 properties that may have previously been or could have become part of the private rental supply. Tax law in Australia also make the option of renting a house on Airbnb appealing, as holiday homes are eligible for tax deductions even if not rented out full time (ATO 2017).

This impact on rental supply can also be considered in terms of vacancy rates. Lee (2016) conducted research investigating the vacancy rates in the Los Angeles and how properties removed from rental market will alter the vacancy rate away from the equilibrium rate, therefore likely increasing rental prices.[5] Barron et al. (2017, p.5) also consider the impact of Airbnb on vacancy rates at the zip code level in the United States, in their study they found that overall Airbnb did not have an effect on vacancy rates, but when separating the types of vacancies, there was a positive association with the portion of homes vacant categorised as for seasonal/recreational use. Due to Australia's current housing affordability issues, we know even small changes in the number of homes available for those seeking a home can have an adverse impact on affordability, amongst both house purchases and tenants. While the number of properties listed on Airbnb may be a small percentage of total housing and rental stock overall, it is increasing and often concentrated in certain areas (Cox 2017). Combined with other factors that reduce the rental vacancy rate, Airbnb's presence in any tight housing market gives further reason for investigation (Gurran & Phibbs 2017, p.83). Gurran and Phibbs (2017, p.88) calculated frequently available Airbnb listings as a proportion of rental vacancy rates, and concluded they represented 145% and 353% of the long term rental stock in the City of Sydney and Waverly respectively. Clearly, frequently listed and potentially full time Airbnb listings, are likely to have had an impact on the rental vacancy rate.

CONCLUSION

This paper has mapped out some of the key ways in which Airbnb may be interacting with the housing market. It is evident that further research on the impact of Airbnb as a new form of disruption to the Australian housing market should be undertaken. This

[4] Retrieved from Inside Airbnb on 27 April 2018, using the 'Only recent and frequently booked' Activity Filter.

[5] The equilibrium rate is the vacancy rate of a rental market that does not result in downward or upward pressure on rental prices.

further research will consider how Airbnb is having an impact on the private rental sector in particular. Additionally, this research will consider the broader influence of Airbnb, particularly for the perspective of local and state government who will need to balance the impact on housing with the potential economic opportunity brought by Airbnb.

REFERENCES

ABS (2017a) *2016 Census QuickStats*, Australian Bureau of Statistics, viewed 13 October, <http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/036>.

ABS (2017b) Snapshot of Australia, updated 27 March 2018, Australian Bureau of Statistics, viewed 17 April,<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Snapshot%20of%20Australia,%202016~2>.

AHURI (2017) *Developing the scale and capactiy of Australia's affordable housing industry*. <http://www.ahuri.edu.au/research/final-reports/278?utm_source=website&utm_medium=homepage&utm_campaign=featuremobile>.

Airbnb (2014) *New Study: Airbnb Community Contributes AUD $214 Million to Sydney and its Suburbs, Brings Tourists to New Neighbourhoods*, Airbnb, Sydney, viewed 13 Ocotber, <https://www.airbnb.com.au/press/news/new-study-airbnb-community-contributes-aud-214-million-to-sydney-and-its-suburbs-brings-tourists-to-new-neighbourhoods>.

Airbnb (2016a) *Airbnb Expands Beyong the Home with the Launch of Trips*, viewed 13 November, <https://press.atairbnb.com/airbnb-expands-beyond-the-home-with-the-launch-of-trips/>.

Airbnb (2016b) *Qantas Partners with Airbnb to Make Frequent Flyers Right At Home*, viewed 04 September, <https://press.atairbnb.com/qantas-partners-with-airbnb-to-make-frequent-flyers-right-at-home/>.

Airbnb (2017a) *Airbnb, Niido to Partner to Support Home Sharing in Apartments*, Airbnb, Airbnb Newsroom, viewed 15 October, <https://press.atairbnb.com/airbnb-niido-to-partner-to-support-home-sharing-in-apartments/>.

Airbnb (2017b) *Airbnb Newsroom: Fast Facts*, Airbnb, viewed 04 September, <https://press.atairbnb.com/fast-facts/>.

Airbnb (2017c) *Airbnb and Flight Centre Travel Group Partner to Expand Accommodation Options for Business Travellers*, viewed 04 September, <https://press.atairbnb.com/airbnb-flight-centre-travel-group-partner-expand-accommodation-options-business-travellers/>.

Airbnb (2018) *Airbnb and Gold Coast Tourism partner to grow tourism pie*, Airbnb, Airbnb Citizen, viewed 16 April, <https://www.airbnbcitizen.com/airbnb-and-gold-coast-tourism-partner-to-grow-tourism-pie/>.

Allen, L, Reimondos, A & Gray, E (2012) *Fewer occupants, more bedrooms: census shows Australians prefer bigger houses*, The Conversation, viewed 13 October, <https://theconversation.com/fewer-occupants-more-bedrooms-census-shows-australians-prefer-bigger-houses-7871>.

ATO (2017) *Holiday homes*, Australian Government: Australian Taxation Office, viewed 27 April, <https://www.ato.gov.au/General/Property/In-detail/Holiday-homes/>.

Badcock, BA & Beer, AP (2000) *Home truths : property ownership and housing wealth in Australia*, Melbourne University Press, Carlton, Vic.

Barcelona City Government (2017) *PUET: The Special Plan for Barcelona Tourist Accomodation*, Barcelona, viewed 22 September, <http://ajuntament.barcelona.cat/pla-allotjaments-turistics/ca/>.

Barron, K, Kung, E & Proserpio, D (2017) 'The Sharing Economy and Housing Affordability: Evidence from Airbnb'.

Beer, A, Kearins, B & Pieters, H (2007) 'Housing affordability and planning in Australia: The challenge of policy under neol-liberalism', *Housing Studies*, vol. 22, no. 1, pp. 11-24.

Beer, A, Faulkner, D, Paris, C & Clower, TL (2011) *Consuming Housing? : Transitions Through the Housing Market in the 21st Century*, Policy Press, Bristol, UNITED KINGDOM.

Botsman, R & Rogers, R (2010) *What's mine is yours : the rise of collaborative consumption*, 1st edn, Harper Business, New York.

Brenner, N (2004) 'The Globalization Debates: Opening Up to New Spaces?', *New State Spaces : Urban Governance and the Rescaling of Statehood*, Oxford University Press, Oxford.

CEDA (2017) *Housing Australia*, Committee for Economic Development of Australia, Melbourne. <http://www.ceda.com.au/research-and-policy/research/2017/housing-australia>.

City Attorney of San Francisco (2017) *Herrera repels legal challenge to short-term rental law, secures settlement with Airbnb and HomeAway*, City Attorney of San Francisco, City Attorney of San Francisco, viewed 27 September, <https://www.sfcityattorney.org/2017/05/01/herrera-repels-legal-challenge-short-term-rental-law-secures-settlement-airbnb-homeaway/>

Cox, M (2017) *Inside Airbnb: Adding data into the debate*, viewed 25 June, <http://insideairbnb.com/>.

Dredge, D & Jamal, T (2013) 'Mobilities on the Gold Coast, Australia: implications for destination governance and sustainable tourism', *Journal of Sustainable Tourism*, vol. 21, no. 4, 2013/05/01, pp. 557-579.

Easthope, H, Troy, L & Crommelin, L (2017) *The Building Scale*, City Futures Research Centre.

Gallagher, L (2017) *The Airbnb Story*, Penguin Random House, London.

Gurran, N (2017) 'Global Home-Sharing, Local Communities and the Airbnb Debate: A Planning Research Agenda', *Planning Theory & Practice*, pp. 1-7.

Gurran, N & Bramley, G (2017) 'Housing, Property Politics and Planning in Australia', *Urban Planning and the Housing Market: International Perspectives for Policy and Practice*, Palgrave Macmillan UK, London, pp. 259-290.

Gurran, N & Phibbs, P (2017) 'When Tourists Move In: How Should Urban Planners Respond to Airbnb?', *Journal of the American Planning Association*, vol. 83, no. 1, pp. 80-92.

Harrison, D (2017) *Airbnb's Global Support to Local Economies: Output and Employment*, NERA Economic Consulting.

Hulse, K, Burke, T, Ralston, L & Stone, W (2012) 'The Australian private rental sector: changes and challenges'.

Hulse, K & Burke, T (2015) 'Housing in 21st-Century Australia: People, Practices and Policies', in R Dufty-Jones & D Rogers (eds), *Housing in 21st-Century Australia: People, Practices and Policies*, Dallas, Dr Rogers , and Rae, Dr Dufty-Jones, Surrey, England, pp. 139-152.

Hulse, K, Martin, C, James, A & Stone, W (2018) 'Private rental in transition: institutional change, technology and innovation in Australia'.

Lee, D (2016) 'How Airbnb Short-Term Rentals Exacerbate Los Angeles's Affordable Housing Crisis: Analysis and Policy Recommendations', *Harvard Law & Policy Review*, vol. 10, no. 1, p. 229.

Morris, A, Hulse, K & Pawson, H (2017) 'Long-term private renters: Perceptions of security and insecurity', *Journal of Sociology*, vol. 0, no. 0, p. 1440783317707833.

Neighbours Not Strangers (2016) Sydney, viewed 19 April, <https://www.neighboursnotstrangers.com/>.

NSW Government (2016) *Final Report - Adequacy of the Regulation of Short-Term Holiday Letting in New South Wales*, Legislative Assembly of New South Wales, Sydney.

NSW Government (2017), *Short-term Holiday Letting in NSW*, NSW Deparment of Planning and Environment, Sydney.

O'Mahony, J, Simes, R & Smirl, L (2017) *Economic effects of Airbnb in Australia*, Deloitte. <https://www2.deloitte.com/au/en/pages/economics/articles/economic-effects-airbnb-in-australia.html>.

Paris, C (1993) *Housing Australia*, Macmillan Education Australia, Melbourne.

Paris, C (2014) 'Critical commentary: second homes', *Annals of Leisure Research*, vol. 17, no. 1, pp. 4-9.

Paris, C & Thredgold, C (2014) 'Second homes and changing populations', *Centre for Housing, Urban and Regional Planning*, p. 110.

Pawson, H, Hulse, K & Morris, A (2017) 'Interpreting the rise of long-term private renting in a liberal welfare regime context', *Housing Studies*, vol. 32, no. 8, pp. 1062-1084.

Rau, J (2016a) *Airbnb boost to SA Tourism*, http://www.premier.sa.gov.au/index.php/john-rau-news-releases/664-airbnb-boost-to-sa-tourism.

Rau, J (2016b) *Airbnb boost to SA Tourism*, 7 June 2016 edn, Government of South Australia, viewed 28 March, <http://www.premier.sa.gov.au/index.php/john-rau-news-releases/664-airbnb-boost-to-sa-tourism>.

Rowley, S, Leishman, C, Baker, E, Bentley, R & Lester, L (2017) 'Modelling housing need in Australia to 2025'.

Share Better 2014, viewed 19 April, <http://www.sharebetter.org/>.

Stephens, M (2017) 'Housing regimes twenty years after Kemey', The Urban Institute, Heriot-Watt University.

Thomas, L (2017) *Airbnb just closed a $1 billion round and became profitable in 2016*, CNBC, viewed 17 November, <https://www.cnbc.com/2017/03/09/airbnb-closes-1-billion-round-31-billion-valuation-profitable.html>.

Tourism Research Australia (2017) *Tourism Businesses in Australia*, Tourism Research Austalia, Canberra.

Valadkhani, A & Smyth, R (2017) 'Self-exciting effects of house prices on unit prices in Australian capital cities', *Urban Studies*, vol. 54, no. 10, pp. 2376-2394.

Wachsmuth, D, Kerrigan, D, Chaney, D & Shillolo, A (2017) *Short-term cities*, McGill University.

AUSTRALIAN HOUSING MARKET AND THE INDONESIAN FOREIGN REAL ESTATE INVESTMENT

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Abstract
Offshore high net worth investors were active in the Australian property market after the Global Financial Crisis 2008. Indonesia is the direct neighbouring country to Australia and the bilateral investment between the two countries represents an important component of the Australia's foreign relation. During the extensive media coverage on offshore investment in Australia housing market, both the number of wealthy Indonesians and their investments in the Australian housing market were allegedly on an increasing trend. This research intends to uncover the factors that influenced Indonesian investors' decision on the Australian residential property market investment by employing a qualitative semi-structured interview with various senior property professionals and investors from both Australia and Indonesia. Uncertainty in the Indonesian regulatory framework was the major "push" factors that resulted in Indonesians' investment into the Australian residential property market. The wealthy Indonesians overseas property ventures were further encouraged by the favourable Australian "pull" factors such as reputable living condition and stable macroeconomic environment. A better understanding on these drivers will assist the policy makers to better grasp the issue related to foreign real estate investment from Indonesia.

Keywords: Foreign Real Estate Investment (FREI); Australian Housing Market; Indonesia Investment; Melbourne; High Net Worth Individuals(HNWIs); Residential Properties; Cross Border Investment; Government Policies.

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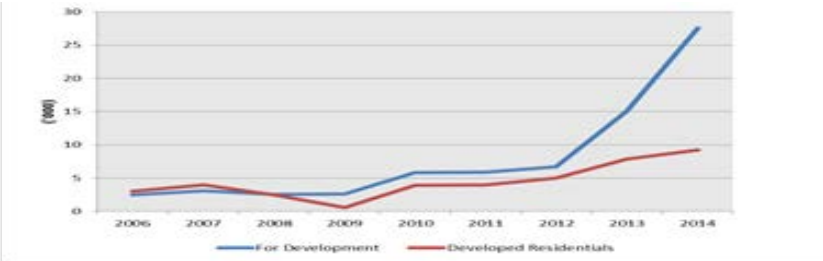
INTRODUCTION

Australian capital city house prices grew 1.4 per cent in December from November in 2016 with an annual growth of 10.9 per cent since 2015, representing the fastest pace since Global Financial Crisis 2008 (GFC)(Glynn, 2017). House prices in both Sydney and Melbourne were at record levels and the media alleged that house prices in Australia went beyond the reach of the majority local buyers especially in desirable locations (AFP, 2014, Birrell, 2013, Economics, 2014). Estimate from the ANU Centre for Social Research and Methods show that the national dwelling prices rose by 19% whilst the household incomes rose by a mere 9.2% after the GFC. In September 2016, the national house price to income ratio was 6.9 times (7.2 times for houses and 6.4 times for units) compares to 4.3 times (4.2 times for houses and 4.8 times for units) 15 years ago. 36.8% of a household's income was required to service an 80% Loan Value Ratio (LVR) mortgage in September 2016 compares to 26.8% of household income in September 2001 (CoreLogic, 2016).

Active participation by foreign investors in the Australian residential property market has been most evident since the GFC. According to National Australia Bank, 16% of the total sales in Australian new housing markets were transacted in the hands of foreign buyers with Foreign buyers' involvement reached 21% in NSW and Victoria in 2015 (NAB, 2015). Figure 1 shows the trend of number of residential real estate approvals for foreign investors in Australia from 2006 to 2014.

Figure 1. **Residential Real Estate Approvals for Foreign Investors.**



Source: FIRB 2015

Figure 1 shows the significant lift in the foreign interest in the Australian residential property market. The 36,800 approvals granted in 2014 represents seven times more than that of 2008's approvals. AFR (2014), Birrell (2013) and Economics (2014) alleged that this is a trend due mainly to FREI from China. Amidst media reports on foreign buying being the main reason for the rising house prices, Guest and Rohde (2015) and Soos (2012) suggested that FREI may have played relatively minor role in the Australian house price growth. Foreign investors' demand was only a marginal contributing factor to the hike in Sydney and Melbourne house prices (Commonwealth Bank, 2014).

MAIN

Foreign Real Estate Investment (FREI) in The Australian Housing Market

In this global liberalisation era, the potential benefits derived from the international real estate in investment strategies resulted in the inclusion of real estate as a common asset class in any international investment portfolio analysis (Sirmans and Worzala, 2003). The real estate sector had successfully attracted significant interest from the international investors due to its increasing level of liquidity, superior returns and offering improved opportunities for diversification (D'Arcy, 2009, Topintzi et al., 2008). Empirical evidence

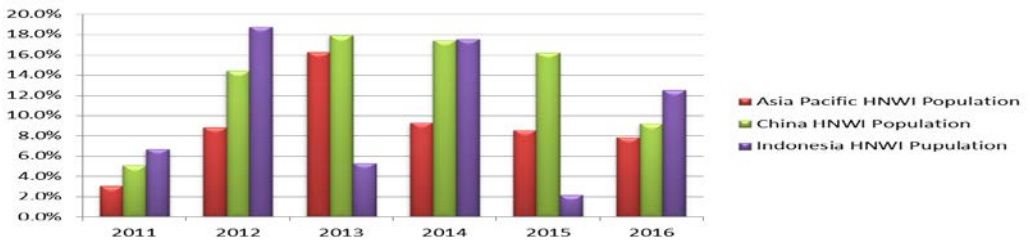
validated that economic factors associated with FREI had influenced the housing market performance in Melbourne (Wong and Wakefield, 2017). The Australian government policies around the foreign investment, education, immigration, tourism and social security benefits have provided the much-needed foundation for a favourable investment environment (Wong, Higgins and Wakefield, 2017a).

Global Private Wealth and The Indonesia High Net Worth Individuals (HNWIs)

Capgemini (2015) and Savills (2014) identified the Asia Pacific region' HNWIs have taken over the western countries' as the biggest investors in the global property market investments. A trend emerged after the GFC that the private bankers and wealthy families stepped into the property market arena that corporate bankers have deserted. Many of them purchased residential properties. The rising private wealth in Asia Pacific was believed to be the driver that increased the cross-border investment activities seeking higher return and diversification and many of them purchases overseas residential properties (KPMG, 2014, Savills, 2014). Wong, Higgins and Wakefield (2017b) identified two non-capitalist factors that drove foreign investment in Australia, namely the Residential Tourism and Education. As Asia Pacific nations and their citizens are getting more affluent and enjoying life styles previously deemed not possible, these affluent Asia Pacific citizens invested into Australia residential property market, as foreigners and tourists, due to the renowned favourable living conditions and standards of education in Australia.

In 2016 the emerging Asia markets including Indonesia, Thailand and India helped offset some of the region's sluggish growth (Capgemini, 2017). Figure 2 shows the percentage changes for the number of HNWI in Asia Pacific, China and Indonesia for the period 2011 to 2016:

Figure 2. **Changes in HNWIs Population.**



Source: Capgemini 2017

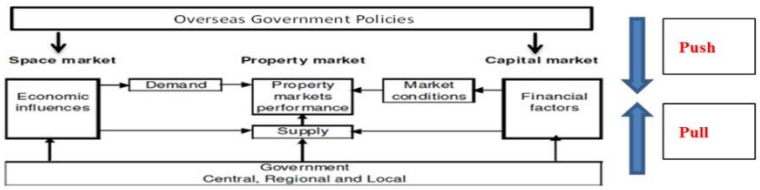
As illustrated in Figure 2, both Asia Pacific and China demonstrate a decelerated percentage increment exposes the recent sluggish growth in their HNWIs population. In contrary Indonesia's HNWIs population grew substantially in 2016 recorded a growth rate of 14.3% (Capgemini, 2017). In his address to the House of Representatives on the inquiry of "Australia's foreign investment policy as it applies to residential real estate", Nikolouzakis (2014) asserted that Indonesia was an emerging market that not only offered immediate economic benefits but had the potential to help nurture one of Australia's most important foreign relationships. His emphasised that predominantly demand is not from Indonesian investors looking for high growth assets but rather from wealthy individuals who want to diversify their investment portfolios into a country with a perceived stable political system and sound judicial framework. There is also demand from Indonesians who would like to send their children to university in Australia (Nikolouzakis, 2014).

There is an apparent need to assess the recent real estate investment decision from the Indonesia perspective based on the emergence of new economic fundamentals following the GFC. This study is expected to yield empirical evidence that will assist the Australian policies makers in harmonising the foreign investments and maintaining the housing affordability in Australia.

The Research Model and Methodology

Following the review of various studies conducted specifically on FDI investments abroad, it is conclusive that the investigation on the source of FDI is equally if not more important in determining the factors affecting FDI in the host country (Culem, 1988, Cushman, 1987, Frey et al., 1985, Froot et al., 1991, Goldberg and Johnson, 1990, Moshirian and Pham, 2000, Nigh, 1986). This study intends to focus on investigating factors that drove Indonesia private wealth into the Melbourne residential property market. This study is an extension of the prior literature and makes allowance for emerging factors and determinants of FREI in the Australian real estate market. Figure 3 illustrates the "Higgins and Peng" model provides an additional assessment platform accommodating overseas' influences over the Space and Financial markets in the host country:

Figure 3. **The "Higgins and Peng" Model.**



Source: Wong & Wakefield, 2017

As per Figure 3, an added component of 'Overseas Government Policies' is incorporated in the "Higgins and Peng" model reflecting its weighty impacts and influences over the space and capital markets of the host country. It is believed that the resultant economic conditions of offshore government policies have impactful influence over the foreign investment outflow and as such, exerted meaningful impact over the Space and Capital market in the host country. Property market supply conditions are very much associated with the policy implementation of local government agencies and thus not related to offshore government policies. The "Higgins and Peng" model provides the fundamental platform of this research for the assessment for various determinants of foreign investments into the Melbourne residential property market.

Qualitative Research – Semi-structured Interview

It is the aim of any qualitative research interview to incorporate a range of approaches into the interviewing process and to see the research topic from the perspective of the interviewee, specifically to understand how and why he or she arrives at a perspective (King, 1994, Teddlie and Yu, 2007). King (1994) and Teddlie (2009) affirmed that a questionnaire can be qualitative (open-ended/unstructured), quantitative (closed-ended/structured) or mixed methods (semi-structured). This method allows for a focus on a particular unit of analysis rather than a collection of analysis of data (Willig, 2013, Yin, 2013).

This research adopted a qualitative assessment approach with a semi-structured interviews technique. The evaluation of new determinants in the Melbourne residential property market can be construed through feedback and discussions with the relevant stakeholders with the following objectives:

i. To identify factors, referring to the Space and Capital markets, influencing the overseas investors' decision on Australian residential property market
ii. To identify government policies and understand the rationale and extent of such government policies causing offshore investments in Australian residential property market

Cross sectional property experts comprise of Indonesia property owners and professionals will be targeted as interviewees for the study. The selection of interviewees shall be based upon their involvement in the residential property industry and seniority in their respective organisation's decision-making process. Figure 4 illustrates the interview approaches adopted in this study to ensure strategic coverage of key stakeholders in the Indonesia and Australia property industry:

Figure 4. **Interview Plan.**

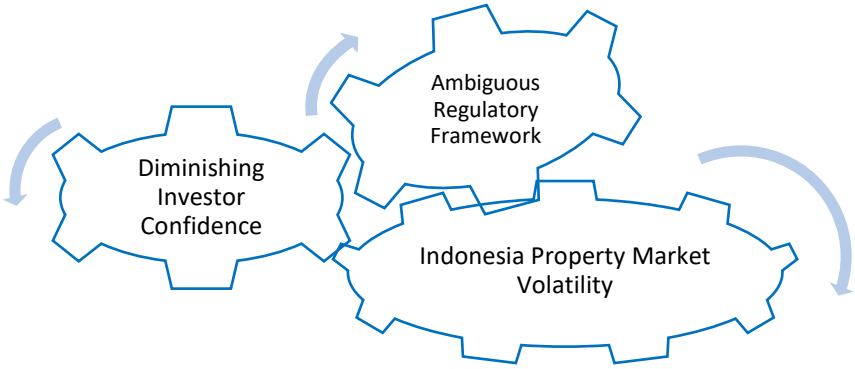
Figure 4 demonstrates the interview plan for key stakeholders in the research. Three key groups were identified as key stakeholders namely the property investors, property developers and property agents. A minimum of one participant from each category was interviewed to ensure that a wide range of opinions and experiences were included in the data sources. Codes have been assigned to each interviewee (Appendix I) to ensure the responses were de-identified thereby providing anonymity for the participants. These codes are used to report interview responses. The interviews were undertaken from June to July 2016. All the interviews are recorded using audio recorder for the Australian interviewees and via Skype for the Indonesia interviewees lasting between 30 and 60 minutes. The interview covered government policies, information on foreign investors, property market conditions, tourist arrival and international student enrolments information. The qualitative data collected (descriptive and narrative) were then transcribed and thematically coded using the qualitative analysis software, NVivo.

OUTCOME

The 'Push' Factors

Figure 5 below summarises the major 'push' factors that encouraged Indonesian overseas investment. Mainly the weaknesses inherited from the government's ambiguous regulatory framework were the main 'push' factor that resulted in higher interest on overseas property investment by the Indonesian residents.

Figure 5. **Indonesia Government Policies and the "Push" Factors.**



The 'Push' Factor 1-Ambiguous Regulatory Framework

Participants agreed it is challenging to conduct property development and investment in Indonesia due to an apparent lacking in affirmative government regulations and guidelines. Investors were exposed to significant risk and forced to deal with ongoing ambiguous business conditions due to lacking in proper guidelines, they call them the "grey areas". For example, a designated residential zone in Indonesia can be changed overnight into an industrial or a commercial zone without prior notice or adherence to any official guidelines. The risk of overnight change in the initial rights and ownerships rested over a property in Indonesia was profound in Indonesia. Participants opined that this short coming constitutes the major risk factor for property investment in Indonesia.

Quotes from the Participants:

"…..That's why sometimes I would like to diverse in Australia due to the uncertainty of the rules and the law. Because sometimes when the land is registered as a, it's a, as a factory area you can change to residential area (anytime)."	Indonesian Developer
"Okay. In property investment in Indonesia, I think number one is the regulations, sometimes there is a bit unclear on how many storeys that you can built and also about the time of - how long you that you have to wait for the permit. There's a bit of a grey area on that side."	Australian Developer
"So sometimes we could get a lot out of the regulations has been changed, but often you could lose money out of it because regulations change and therefore you got to pay, for example, tax…..So, yeah, often you will lose a lot through the regulations that keep changing.	Investor 1

The 'Push' Factor 2-The Diminishing Investor Confidence

Property investors are constantly exposed to the risk of frequent change in the Indonesian government guidelines. This uncertainty had deterred the domestic investors' confidence significantly in Indonesia property market over time, especially when comparisons were made to other mature market place such as Australia.

Quotes from the Participants:

"It's vastly different than what we have here in Australia. I'm probably more familiar with Australian law. And there's a lot of trustworthiness issue I guess in Indonesia whereas you have to look who's the seller or pretty much who's the developer."	Australian Property Agent
"I know regulations made by government they are also depending on the economics of Indonesia, as I told you before, it is going up and down. The same as the current regulations in Indonesia. It changes all the time."	Indonesia property agent
"In the recent years the politics are getting shaky. There are uncertain regulations and especially it's affects the economic in Indonesia, internally and externally. It makes the buying power of Indonesian weaker and slowing down."	Investor 1

The "Pull" Factor 1-Stable Investing Environment in Australia

Participants agreed that the relatively stable regulatory framework in Australia is the main attraction for the Indonesian property investors. The clear-cut regulatory framework and guidelines has provided the much-needed ownership certainty on investing in property in Australia. Contrary to the uncertainty evolving around the property rights and ownerships in Indonesia, investors are confident on their legal ownerships and entitlements over the property they invested in Australia.

Quotes from the Participants:

"… in contrast of Indonesia, Australia is a developed country….. we know that Australia economic is going consistent and stable……in the long term and safe investment, Australia will be one of the best."	Investor 2
"I think in terms of how it encourage my investment is because Australia is already developed country and therefore it is economically and politically stable."	Indonesian Investor
"As an investor what encourage me with regulation would be it's, in terms of regulation it's very clear once you, whenever you want to buy a property here, the property agent will tell you all the regulations"	Investor 1

The 'Pull' Factor 2-Superior and Secured Living Condition in Australia

Liveability was the major aspect that caught the attention of the Indonesian property investors in Melbourne, Australia. Overall Australian cities enjoyed high ratings in the five categories stipulated by The Economist's i.e. stability; healthcare; culture and environment; education; and infrastructure. Foreigners who visited Australia were impressed by its world class education, healthcare, social security and admirable living standards. Australia had emerged a strong contender in the investors' choice to live and retire in the long run. The fact that Melbourne was named the most liveable city in the world 5 years consecutively validated investors' decision.

Quotes from the Participants:

"I believe in the most liveable city…..I believe because of the balance, the work/life balance, and the work/life balance…..the standard of living in Melbourne is high…..absolutely it is a pride for us to say "Whoa I am living in one of the most liveable city" compared to the other city"	Investor 2
"...you're confident with your decision because it's been nominated six times in a row……when you talk with other investors you are saying that you are investing in Melbourne they are like "Oh yeah, yeah, we've heard about Melbourne"	Investor 1
"Most of my clients have their kids study here, as an international student, in the universities here. That's why they invest in Melbourne….. Melbourne being the most liveable city really does attract a lot more investors."	Australian Property Agent and Mortgage Broker
"it's been six years in a row if I'm not mistaken. So this is really like a huge advantage of buying property in Melbourne."	Indonesian Property Agent

CONCLUSION

The aim of this study is to explore the emerging determinants of Indonesian investments in the Australian residential housing markets, particularly in the city of Melbourne that has experienced significant growth since GFC. A series of semi-structured interviews were conducted in Indonesia and Australia to identify factors influencing the Indonesian investors' decision and the relevant government policies attracting or discouraging Indonesian investments on the Australian housing market. Assessment conducted on Indonesia government policies was proven a challenging phase of the research both in terms of the sensitivity and complexity of interview exercise. The research was guided

by the "Higgins and Peng" model employing an open-ended interviewing approach to solicit in-depth "push" factors while carefully avoiding potentially sensitive elements.

According to the interviewees, the Indonesian investors were "pushed" to venture overseas due to the apparent lacking in clear-cut and affirmative regulatory property investment framework in Indonesian. The resultant higher risk involved in the Indonesian property investment had diminished investors' confidence. All interview participants opined that Australia has emerged internationally relevant in many aspects and highly ranked in terms of stability and liveability. The Australian government policies in foreign investment, education, immigration, tourism and social security benefits have provided the foundation for a favourable investing environment. As the world becomes more transparent with globalization and advancement in information technologies, these favourable drivers were quickly acknowledged and acted upon by global real estate investors engaging in cross border real estate transactions in Australia.

REFERENCES

AFP. 2014. Chinese To Splurge $39bn on Australian homes: study. *Agence France-Presse*, 5 March, viewed 12 March 2014, <https://sg.news.yahoo.com/chinese-splurge-39-bn-australian-homes-study-075405722--finance.html>.

Birrell, B. 2013. Melbourne's High Rise Apartment Boom. *CPUR Research Report* September 2013.

Capgemini 2017, *Asia-Pacific Wealth Report 2017*, Capgemini, viewed 19 Dec 2018, <https://www.worldwealthreport.com/apwr>.

Clennell, A 2017, 'Foreign property buyers are pricing locals out of the market', *The Daily Telegraph, 14 March*, viewed 3 December 2017, <https://www.dailytelegraph.com.au/news/nsw/foreign-property-buyers-are-pricing-locals-out-of-the-market/news-story/00b094cfb7c0e83a71f2a85f6866397a>.

CommonWealthBank, A. 2014. Demand and House Prices. *Global Market Research Eonomics: Issues*. Sydney: Australian Commonwealth Bank.

Corelogic, 2016. Housing Affordability Report December 2016, *CoreLogic Asia Pacific*, Sydney, viewed 10 March 2017, https://www.corelogic.com.au/reports/CL_Housing-Affordability-Dec_2016.pdf

Culem, C. G. 1988. The locational determinants of direct investments among industrialized countries. *European economic review*, 32, 885-904.

Cushman, D. O. 1987. US bilateral trade balances and the dollar. *Economics Letters*, 24, 363-367

D'arcy, É. 2009. The evolution of institutional arrangements to support the internationalisation of real estate involvements: Some evidence from Europe. *Journal of European Real Estate Research*, 2, 280-293

Donovan, J 2014, 'Wake up to Indonesia's investment potential', *The Australian*, 2 April, viewed 8 December 2017, < http://www.theaustralian.com.au/business/business-spectator/wake-up-to-indonesias-investment-potential/news-story/5aa523e1838bcc7ddcf30f5f05a41052>.

Economics, H. S. C. O. 2014, Inquiry into foreign investment in residential real estate. Committee activities (inquiries and reports), *House Standing Committee on Economics*, viewed 25 July 2014, http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=economics/foreigninvestment/index.htm.

Fereidouni, H. G. & Tajul Ariffin, M. 2013. Real estate market factors and foreign real estate investment. *Journal of Economic Studies*, 40, 448-468.

FIRB 2013, Annual Report 2012-13. In: BOARD, F. I. R. (ed.), *industry report, Foreign Investment Review Board*, viewed 5 May 2014, retrieved from https://firb.gov.au/files/2015/11/FIRB-Annual-Report-2012-13.pdf.

FIRB 2015, Annual Report 2014-15. In: BOARD, F. I. R. (ed.), *industry report, Foreign Investment Review Board*, viewed 25 February 2016, retrieved from < http://firb.gov.au/about/publication/annual-report-2014-2015/>.

Frey, B. S., Schneider, F. & Pommerehne, W. W. 1985. Economists' opinions on environmental policy instruments: analysis of a survey. *Journal of Environmental Economics and Management*, 12, 62-71.

Froot, K. A., Perold, A. F. & Stein, J. C. 1991. Shareholder trading practices and corporate investment horizons. *National Bureau of Economic Research*.

Glynn, J. 2017, ' National house price growth at 10.9pc in 2016: *CoreLogic', The Australian*, 3 January, viewed 20 April 2017, < http://www.theaustralian.com.au/business/property/national-house-price-growth-at-109pc-in-2016-corelogic/news-story/0181a6fa323f09b3aff8cf27d492aa2c>.

Goldberd, L. G. & Johnson, D. 1990. The determinants of US banking activity abroad. *Journal of International Money and Finance*, 9, 123-137.

Guest, R., Rohde, N. 2015. Was the housing boom in Sydney and Melbourne driven by foreign buyers?, *the Conversation*, 21 December, viewed 2 May 2016, < http://theconversation.com/was-the-housing-boom-in-sydney-and-melbourne-driven-by-foreign-buyers-51389>.

Hoesli, M., Lekander, J. & Witkiewicz, W. 2004. International evidence on real estate as a portfolio diversifier. *Journal of Real Estate Research*, 26, 161-206.

Janda, M. 2014, 'Chinese buyers to invest $44b in Australian real estate', *ABC News*, 5 March, viewed 10 March 2014, http://www.abc.net.au/news/2014-03-05/chinese-buyers-to-invest-44-billion-dollars-in-australian-real-/5300494.

King, N., Cassell, C. & Symon, G. 1994. Qualitative methods in organizational research: A practical guide. *The Qualitative Research Interview*.

KPMG 2014. Demystifying China Investment in Australia. Sydney: *KPMG*.

Moshirian, F. & Pham, T. 2000. Determinants of US investment in real estate abroad. *Journal of Multinational Financial Management*, 10, 63-72.

NAB 2015, NAB Residential Property Survey: Q1 2015, *National Australia bank*, viewed 1 May 2015, http://business.nab.com.au/wp-content/uploads/2015/04/Quarterly-Australian-Residential-Property-Survey-Q1-2015-PDF202KB.pdf.

Nigh, D. W., Cho, K. R. & Krishnan, S. 1986. The role of location-related factors in US banking involvement abroad: an empirical examination. *Journal of International Business Studies*, 17, 59-72.

Nikolouzakis, B 2014, 'Increased Indonesian interest in Australian residential property market a boost for local economy, says Nyko', *Nyko Property*, blog post, 17 July, viewed 8 December 2017, < http://www.nykoproperty.com.au/increased-indonesian-interest-in-australian-residential-property-market-a-boost-for-local-economy-says-nyko/>.

Parliament of Australia Parliamentary Business 2017, *Australia's trade relationship with Indonesia, Parliament of Australia* , viewed 1 December 2017, <https://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Trade_and_Investment_Growth/IndonesiaTrade/Report_1/section?id=committees%2Freportjnt%2F024065%2F24601>.

Savills 2014, Around The World In Dollars and Cents - How Private Money Moves Around The Real Estate World, *Savills World Research 2014*, viewed 20 July 2014, http://www.savills.co.uk/research_articles/188297/171998-0.

Schlesinger, L. 2015, 'Chinese property buyer myths busted', *Financial Review*, 1 March, viewed 8 March 2015, http://www.afr.com/real-estate/residential/chinese-property-buyer-myths-busted-20150227-13r0n4.

Sirmans, C. F. & Worzala, E. 2003. International Direct Real Estate Investment: A Review of the Literature. *Urban Studies*, 40, 1081-1114.

Soos, P. 2012. Don't blame foreign investment for rising house prices, *the Conversation*, 1 August, viewed 2 May 2016, < http://theconversation.com/dont-blame-foreign-investment-for-rising-house-prices-8340>.

Teddlie, C. & Tashakkori, A. 2009. Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences, *Sage Publications Inc*.

Teddlie, C. & Yu, F. 2007. Mixed methods sampling a typology with examples. *Journal of mixed methods research*, 1, 77-100.

Topintzi, E., Chin, H. & Hobbs, P. 2008. Moving towards a global real estate index. *Journal of Property Investment & Finance*, 26, 286-303.

Topsfield, J & Rompies, K 2017, 'Australia-Indonesia free trade deal will encounter Protectionism', *The Sydney Morning Herald*, 29 August , viewed 1 December 2017, < http://www.smh.com.au/business/world-business/australiaindonesia-free-trade-deal-will-encounter-protectionism-20170829-gy6eu5.html>.

Wong, P., Wakefield, R. 2017. 'The Australian Residential Property Market: A Study on Foreign Real Estate Investment', in *Proceedings of 41st AUBEA 2017*, Melbourne, Australia, 3-5 July 2017, pp. 315-329.

Wong, P.Y., Higgins, D.M. and Wakefield, R., 2017a. Chinese investors investment strategies in the Australian residential property market. *Pacific Rim Property Research Journal*, 23(3), pp.227-247.

Wong, P.Y., Higgins, D. and Wakefield, R., 2017b. Foreign real estate investment, residential tourism and the Australian residential property market. *International Journal of Housing Markets and Analysis*, 10(5), pp.586-606.

Willig, C. 2013. Introducing qualitative research in psychology, *McGraw-Hill Education* (UK).

Wilson, D. 2008. The Expanding Middle: The Exploding World Middle Class and Falling Global Inequality. *Goldman Sachs Global Economy Paper*, 170.

Yin, R. K. 2013. Case study research: Design and methods, *Sage publications*

APPENDIX I

Role in organisations	Type of organisation	Location	Code used for analysis
Managing director	Medium listed residential property developer in south eastern suburb	Melbourne, inner suburb	Australian Developer
Owner	Medium listed residential and commercial property developer in Surabaya and Jakarta, Indonesia	Surabaya, Indonesia	Indonesian Developer
Property Sales Consultant	Real Estate Agent for Melbourne CBD, inner suburb (eastern suburb and southeastern suburb)	Melbourne inner suburb	Australian Property Agent
Managing Director	Real Estate Agent for Melbourne CBD and South East suburb	Melbourne CBD, Australia	Australian Property Agent and Mortgage Broker
Managing Director	Real Estate Agent for medium and high residential development	Surabaya, Indonesia	Indonesian Property Agent
Residential Property Investor	Private	South Melbourne, Australia	Investor 1
Residential Property Investor	Private	Melbourne CBD, Australia	Investor 2
Residential Property Investor	Private	Jakarta, Indonesia	Indonesian Investor

REVIEW OF DOMESTIC BUILDING CONTRACTS ACTS FOR CONSTRUCTION OF LOW-RISE RESIDENTIAL BUILDINGS

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Abstract
Erstwhile studies related to defects associated with newly constructed low-rise domestic buildings in the state of Victoria, Australia indicates that defects per house in detached residential houses have increased. Over the last three decades, in an attempt to improve quality in residential houses built in Victoria, there has been significant legislative changes to the domestic building contracts; however, current guidelines fall short to achieve the desired qualitative outcome. The purpose of this research is to review and evaluate the Domestic Building Contracts Acts across states in Australia, where the highest volume of residential building construction is undertaken, and subsequently proffer recommendations which could assist to reduce defects in domestic buildings in Victoria. In this phase of the research, a systematic review of the literature has been conducted and the research gaps identified. Research articles which investigated defects in buildings were analysed with respect to the country of origin, authors and their affiliations. The Victorian Domestic Building Contracts Act 1995 and the New South Wales (NSW) Home Building Act 1989 which are the current acts in both states were reviewed. Findings from an extensive review indicate that some of the Sections incorporated in the NSW Home Act, that helps to reduce defects in low-rise residential buildings are not included in the Victorian Domestic Building Contracts Act. It is suggested that lessons can be learnt from NSW Home Building Act, and Sections which could assist to minimise defects in residential buildings should be included in the revised version of Victorian Domestic Building Contracts Act.

Keywords: Defects; Low-rise; Residential Building; Australia; Domestic Building Act.

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INTRODUCTION

In Australia, low-rise residential building works constitutes a significant percentage of the total value of the building works undertaken nationally. According to the Australian Bureau of Statistics (ABS), in the year 2016, the proportion of the total value of building works done in the residential and non-residential sector is 66% and 34% respectively (ABS 2017a). Victoria and New South Wales (NSW) are the two states where the majority of low-rise building construction activities are carried out, and as a result, most of the complaints associated with building defects are from these states (AWCI 2017). At the inception stage of this research, the focus was, therefore, to review and holistically evaluate the Domestic Building Contracts Acts in the two states. By March 2017, the residential building works volume in New South Wales and Victoria is about 34% and 31% of the total value of residential building works undertaken nationally (ABS 2017b).

Previous studies recently completed indicate that the number of defects per building in the State of Victoria was increasing. Georgiou et al. (1999) found, on average of, about two defects per house in Victorian low-rise residential buildings constructed between 1988 and 1996. Subsequently, Georgiou (2010) and Georgiou (2016) concluded that the number of defects per house for residential buildings constructed from 1997 to 2004 is five. The occurrence of these defects ultimately results in unnecessary costs on the side of the builder and homeowners. According to Mills et al. (2009), the cost of rectifying the defective works in the Victorian residential building is about 4% of the contract value.

On the other hand, the use of more stringent Domestic Building Acts has the potential to minimise the rate of defects in residential buildings. In Victoria State, incomplete work items and workmanship related problems are the two main categories of residential building defects (Georgiou 2010). Nonetheless, the inclusion of clauses which oblige builders to carry out rigorous supervision and quality control by a competent person in the Domestic Building Contracts Act could reduce the adverse effects of the workmanship related defects. Thus, the objective of this research is to review the Domestic Building Contracts Acts in Victoria and NSW states and recommend provisions that could assist to reduce the defects in residential buildings in the State of Victoria.

RESEARCH METHODOLOGY

A systematic review of the literature was conducted to identify the knowledge gaps. The keywords ‘defects,’ ‘building’ and ‘construction’ were used to search articles containing these keywords in their Titles, Abstracts and Keywords. Accordingly, 512 articles were identified during the initial stage. Searching was limited to the Journals which frequently (more than three papers) publish the articles related to defects in buildings, of which 118 articles were identified.

The articles were analysed with respect to the country of origin, authors and their affiliations. Finally, the research gap was identified. The Domestic Building Contracts Acts of Victoria and NSW were then reviewed and compared; and provisions which could assist to minimise the defects in residential buildings in Victoria are recommended.

LITERATURE REVIEW

Lo et al. (2005) investigated defects in roof construction of medium-rise buildings in tropical climates and found that parapet wall failure led to tearing of waterproofing membrane. Forcada et al. (2012a) identified the post-handover defects in Spain, and the study revealed that the most common defects were derived from poor workmanship and were related to construction errors and omissions. The typical defects identified in the study were incorrect installation, appearance defects, and missing items or tasks mainly related to finishing. Similarly, Forcada et al. (2012b) found that incomplete tile grouting

and incorrect fixtures and fittings in toilets were the most frequent defects in residential buildings in Spain. Del Solar et al. (2015) studied defects in ceramic claddings and found that errors in piece layout, excessive visibility of joints, uneven surfacing and hollow zones were some of the major defects. According to Carretero-Ayuso et al. (2015), fissures in walls and flooring, cracks in structural elements, and infiltration of humidity are some of the defects in residential buildings.

Atkinson (1999) found that human errors are the main sources of defects. According to Olubodun and Mole (1999), the causative factor for defects could be categorised under design, construction, age, changing standards and vandalism. Assaf et al. (1996) indicated that faulty design and construction are the two main causes of defects in buildings. Chew (2005) concluded that the sources of defects are related to deficiency in construction, design, material and maintenance practices. Mohd-Noor et al. (2016) found that usage factors such as impact damage or vandalism, change of use, and normal wear; environmental factors including artificial movement/vibration, natural movement/vibration and ageing, including construction factors which are related to material selection and workmanship were associated with some of the major causes of defects.

Georgiou et al. (1999) compared the defects in houses constructed by homeowners and registered builders and found no significant quality difference between the houses delivered by the two categories of builders. Chong and Low (2005) studied the differences among the defects that occurred during construction and between two to six years after initial occupancy and found that the defects during both periods were very different. According to the research, some construction defects become latent defects, while some latent defects began to emerge. The study concluded that construction materials related defects could take time to develop and will usually appear during occupancy rather than during construction; similarly, any faults committed by the designers might not usually appear during the construction phase. Most construction defects are the result of poor workmanship and lack of protection, and as buildings aged, design, material, and maintenance defects became more apparent (Chong and Low 2005). Johnsson and Meiling (2009) compared the defects in industrialised housing and ordinary construction and found that industrialised buildings are better in terms of product quality. Georgiou (2010) investigated building defects under two different Acts of the Parliament of Victoria, Australia and concluded that changes in legislation might not reduce the defects.

Chew and Tan (2004) built a regression model for predicting the maintainability of wet areas in buildings in Singapore. According to the research, plumbing selection, access for fitting maintenance, material maintainability, usage and construction quality were the most significant parameters associated with the maintainability of wet areas. The structural behaviour of Glass fibre-reinforced concrete (GRC) panels which exhibited cracking and excessive deformation was simulated with a finite element method (FEM) by Correia et al. (2006). Sommerville (2007) prepared the conceptual models of defects and rework which can be used to minimise the impact of defects and rework on future developments.

Josephson and Hammarlund (1999) estimated the cost of defects in construction using case studies of seven building projects. Accordingly, the cost of defects was about 4.86% of production cost. Mills et al. (2009) concluded that the cost of rectification of residential building defects in Victoria could reach up to 4% of the construction contract value. Mills et al. (2010) found that the direct cost of rework in the construction industry of Australia accounts for 12.4% of total contract value.

Finally, in the context of Australia, a few periodic studies which address the effect of regulatory requirements in reducing defects in residential buildings were conducted.

Georgio (2016) and Georgiou (2010) concluded that despite the change in the Act from House Contracts Guarantee Act (HCGA) 1987 to Domestic Contracts Tribunal Act 1995 (DBCTA) in the state of Victoria, the number of defects per house has not reduced. However, a little or no research was conducted to compare the Residential Building Contracts Acts in various states in Australia and recommend the adoption of good provisions. For instance, Victorian Domestic Contract Act and New South Wales Home Building Act were not reviewed and analysed to identify the provisions of an Act which could help to reduce defects in the residential buildings in Victoria. Good contract clauses in one state could be adopted in another and could potentially mitigate defects in residential buildings.

THE VICTORIAN DOMESTIC BUILDING CONTRACTS ACT 1995

In this study, Version No. 78 of the Act which incorporates the amendments as of 1 September 2016 is reviewed (Government of Victoria 2016). The Act comprises of six Parts. The purpose of the Act, the commencement date, definitions, the objects of the Act, building work to which the Act applies and the building work to which the Act does not apply are stipulated in Part 1.

Part 2 has five Divisions. The general warranties (Division 1) stipulate that the builder should carry out the works in a proper and workmanlike manner, in accordance with the plans and specifications, and with reasonable skill and care. Section 8 of the Act also explains that the builder warrants the work will be completed by the date specified in the contract; the building work should be executed in accordance with all laws and legal requirements; the materials to be used should be suitable for the purpose for which they are used; and the work and materials will be reasonably fit for the purpose. Division 2 of Part 2 describes the limit of the amount of deposit. Accordingly, a builder should not receive more than 5% if the contract price less than AU$20,000. If the contract price exceeds AU$ 20,000, the amount of deposit should not be greater than 10% of the contract price. Division 2 also explains the restrictions on the cost-plus contracts and cost escalation clauses. Division 3 of Part 2 specifies that a builder should allow the building owner or a person authorised by the owner to access the site and see any part of the building works. According to the Act, a person who has a right to access the building site must not interfere with the execution of the building works. The builder is not liable for any delays or costs associated with the interference of the person. Division 4 of Part 2 explains the warranty for the provisional sum. According to Section 20 of the Act, the builder should calculate the provisional sum with reasonable care and skill by considering all the information such as the nature and location of the site. As per Division 5 of Part 2, the builder must give the building owner the copies of a report, notice or order that a builder is given by any public statutory authority or provider of building services or a person registered under the Building Act 1993.

Part 3 comprises of six Divisions. According to Domestic Building Contracts Act 1995, any domestic building contract with the contract price exceeding AU$5,000 is categorised as a major domestic building contract. The Act clearly states that a builder should not enter into such contracts unless they are registered and have an approved building insurance cover. However, in the recent amendments of the Building Act 1993 Version No. 110, this threshold for works that require registration has increased to AU$ 10,000 effective 1st August 2017. Division 2 of Part 3 describes the contents of a contract including plans and specifications, the registration number of a builder, the project start and completion dates among others. Division 3 states that the building owner may end contract within five days (cooling-off period) without penalty. Section 37 and 38 specifies the procedures to be followed by the builder and owner of the building to issue variations

of the plans and specification from the original contract. In Division 5 of Part 3, conditions for ending a contract are provided. Accordingly, the owner of a building may end the major domestic building contract if the contract price rises by more than 15% or the contract is not completed within 1.5 times the period it was to have been completed. Section 42 stipulates that a builder should not request final payment until the building owner is given either a copy of the occupancy permit or the certificate of final inspection.

Part 4 describes the appointment of inspectors in the event of any dispute arises from the domestic building contract. According to Section 44(2), a person who is a party to a dispute may request the Authority to appoint an inspector who can investigate whether the domestic building work executed by a builder is defective or not. Section 46 explains that the inspector may conduct any relevant tests in accordance with the Domestic Building Contracts Acts 1995 Version 78. Section 48(3) obliges the inspector to recommend what should be done to rectify any defective work that he/she believes is defective. Part 5 of the Act describes the settlement of building disputes and the role of the Tribunal. According to Section 53(1) of the Act, the Tribunal may issue an order it considers fair to settle a domestic building dispute. The Tribunal can also order the rectification of defective building work and completion of incomplete building work. Finally, Part 6 of the Act provides information regarding the establishment of Domestic Builders Fund into which all the fees received by the Tribunal in respect of the proceedings of the Act are paid. The expenses incurred in the enforcement of the Act are also paid out of the Fund.

THE NEW SOUTH WALES HOME BUILDING ACT 1989

In this research, the October 2016 version of the Home Building Act 1989 No. 147 is reviewed (Government of NSW, 2016). The Act consists of eight Parts. The name of the Act, commencement of the Act, and provision of completion dates of residential building works are some of the Sections included in Part 1 of the Act.

Part 2 comprised of two Divisions. Section 4 of Part 2 specifies that a person should not contract to do "*any residential building work*" without having a contractor licence. The forms of contracts and the cooling-off period (5 days) are also stipulated in Division 1 of Part 2. Section 7BA provides that the cooling-off period may be shortened or avoided by a provision in the contract. According to Section 8 of Part 2, the maximum amount of deposit for a residential building work is 10% of the contract amount. Division 2 of Part 2 specifies individual who can do certain residential work. Section 13 explains that an individual must not execute any residential building work, except as the holder of an endorsed contractor licence, a supervisor or tradesperson certificate. The Act stipulates 1,000 penalty units in the case of a corporation and 200 penalty units in any other case for the contravention of Section 13 of the Act. Section 14 specifies that an individual should not perform any electrical wiring work except as a qualified supervisor of that work or as the holder of tradesperson certificate under the supervision of a qualified supervisor. According to Section 15, an individual must not do refrigeration or air-conditioning work unless as the holder of an endorsed contractor licence, or a supervisor or tradesperson certificate which authorises the holder to do that work. Part 2 also incorporates provision for statutory warranties. The Act stipulates that the holder of the contractor licence warrants that the work will be done with due care and skill and in accordance with the plans and specifications; all materials supplied are good and suitable for the purpose for which they are used; and the work as well as any materials used in doing the work are fit for the specified purpose. Section 18E specifies that the warranty period is six years for breaches that result in a major defect in the residential building work or two years in other cases. According to Home Building Act 1989 No. 147, the

major defect refers to a defect in a main element of a building which arises due to defective design, faulty workmanship, and defective materials that cause the inability to inhabit the building or its part for the intended purpose; or the destruction of the building or its parts; or a threat to failure of the building. Similarly, the main element of a building is defined as external or internal load-bearing components which are necessary for the stability of the building or parts of it such as foundations, floors, walls, roofs, columns and beams or a fire safety system or waterproofing.

Part 3 has five main Divisions. According to Division 1 of Part 3, the license issuing authority must refuse a contractor licence if the authority is not satisfied with the applicant's proposed arrangements for supervision of the building work. Furthermore, the authority may refuse the contractor licence if an employee or proposed employee of the applicant is disqualified from holding a contractor licence or had an application refused because of his/her character, honesty and integrity. Section 23 stipulates that the licence issuing authority may authorise the publication of warning notices by advertisement by the use of any medium if the contractor licence holder has a recent history of unreasonable delays in completing works or if there is defective or inadequately supervised work.

In Division 2 of Part 3, it is specified that the Authority involved in issuing the supervisor or tradesperson certificate must refuse the applications if the Authority is not satisfied that the applicant is a fit and proper person to hold such certificate. According to the Act, to determine whether an applicant is a fit and proper person, the character, honesty, integrity and reputation of the applicant is considered. The Authority should also refuse the application for the supervisor or tradesperson certificate if the applicant has not completed any relevant examination or practical test or both conducted or nominated by the Authority. According to Section 27, the holder of a supervisor certificate is authorised to do and to supervise any residential building work that is described in the certificate whereas the holder of a tradesperson certificate is authorised to do a specialist work that is described in the certificate but only under the general supervision, and subject to the control of the holder of an endorsed contractor licence or a supervisor certificate authorising supervision of the work.

Division 3 of Part 3 explains that the Authority issuing the owner-builder permit must refuse an application if the Authority is not satisfied that an applicant has completed any education or training required for the grant of the permit. The procedures followed in resolving building disputes and building claims are also explained in Part 3 of the Act. According to Section 48D, an inspector may be appointed to investigate any matters related to a building dispute. The inspector may issue a rectification order if any residential building work or specialist work undertaken by the contractor is defective.

Part 4 of the Act provides Sections related to the improper conduct of the holder of a contractor licence or supervisor or tradesperson certificate. For instance, if the holder of a certificate execute a work without due care and skill or knowingly uses faulty or unsuitable materials in the course of doing the work, then the certificate holder is guilty of improper conduct and the Authority could take necessary disciplinary actions. The disciplinary actions include payment of up to AU$11,000 (in the case of an individual) or AU$50,000 (in the case of a corporation), or impose an order that the holder undertake necessary training required for the proper execution of a particular type of work, or suspension or cancellation of the licence or certificate.

Part 5 of the Act addresses issues such as appeals and unjust contracts. Part 6 specifies that the contractor work should be insured. According to Section 92, a person must not demand or receive a payment under a contract for residential building work unless a certificate of insurance evidencing the contract of insurance has been provided to the other party. Part 7 of the Act comprise of Sections which explain the functions of

the Secretary under the Act, Constitution of Administration Corporation and Functions of Administration Corporation among others. Finally, Part 8 (General) outlines provisions for inspections reports on dwellings, premises affected by loose-fill asbestos insulation and a miscellaneous section.

COMPARISON OF COMPLAINTS RELATED TO RESIDENTIAL BUILDING DEFECTS IN VICTORIA AND NSW

The number of complaints and disputes due to the defective building works in Victoria and NSW states in the last six years (2010-11 to 2015-16) is shown in Figure 1. Accordingly, for the entire six years period, the number of complaints and disputes per year in residential buildings in NSW is relatively low. However, in Victoria, there is a continual upward trend in the number of complaints and disputes between the year 2010-11 and 2013-14 (data source: AWCI (2017)).

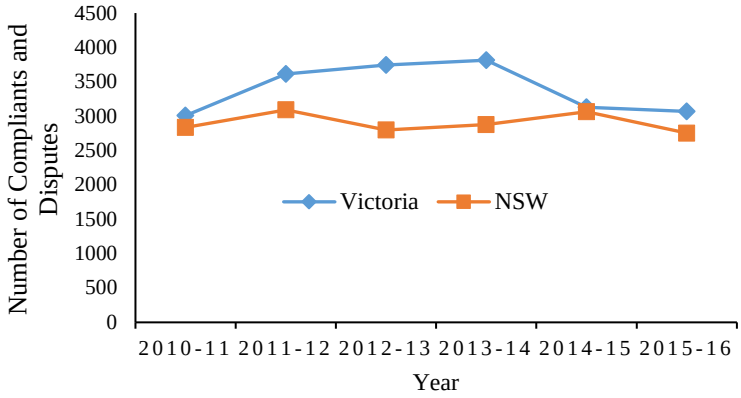

Figure 1: Number of Defective Building Work Complaints and Disputes per Year

However, since the number of complaints and disputes could be influenced by the volume of building works, the number of complaints and disputes per year is divided by the total annual value of residential building works in each state and the result is shown in Figure 2. Accordingly, the number of complaints and disputes per value of the residential building works per year is higher in the state of Victoria since the year 2012-13.

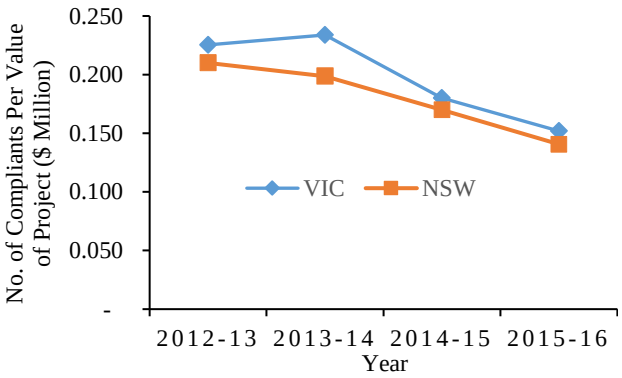

Figure 2. Number of Defective Building Work Complaints and Disputes Per Value of Residential Building Works (data source: AWCI (2017) and ABS (2017b)).

DISCUSSION

The review of the Victorian and New South Wales (NSW) residential building contracts Acts indicates that some Sections which assist in reducing the defects in building construction are not included in the Victorian Domestic Building Contracts Act 1995 (Government of Victoria 2016). The New South Wales Home Building Act 1989 has many provisions that have the potential to decrease the defects in residential building construction (Government of NSW 2016). For instance, the Home Building Act 1989 has a dedicated Part having numerous Sections which stipulate the issues related to the licence and certificates of individuals who are involved in residential building construction (Part 3 of the Act). A contractor's licence may be refused if the authorities are not satisfied with the applicant's arrangement for supervision of the building work. Furthermore, the NSW Home Building Act has more stringent requirement for issuing a supervisor or tradesperson certificate. The applicant's character, honesty, integrity and reputation are considered. Furthermore, the Act stipulates that the Authority issuing the certificate should refuse the application for either supervisor or tradesperson certificate if the applicant has not completed any relevant examination or practical test or both conducted by the Authority or other nominated companies.

The penalties associated with the improper conduct of the holder of contractor's licence, supervisor or tradesperson certificate are stipulated in the NSW Home Building Act 1989 but not in Victorian Domestic Building Contracts Act 1995. According to the NSW Home Building Act 1989, the execution of building works without due care and skill, or the deliberate use of faulty or unsuitable materials are considered as improper conducts. The penalty associated with the contravention of the Act by the holder of the licence or certificate could reach up to AU$11,000 for individuals. The authority that issued the licence or certificate can also revoke the supervisor or tradesperson certificate or contractor licence on the basis of the improper conducts. In Victoria State, the Victorian Building Authority (VBA) stipulates the disciplinary actions only for building practitioners such as domestic builders but not for tradesperson (Government of Victoria 2017). On the other hand, in NSW, the tradesperson as well as the supervisors are required to have appropriate skills which can be verified by examinations or practical tests before being involved in a residential building construction. Such aforementioned practice could assist in curbing construction defects if incorporated in the Victorian Building Act.

The findings of the previous studies in Victoria show that defects related to workmanship and incomplete items are the two most common defects. According to Georgiou et al. (1999), about 40% of the defects in residential buildings in Victoria are caused by workmanship problems. Similarly, Georgiou (2010) found that more than 70% of the defects are due to faulty workmanship. Mills et al. (2009) estimated the costs of defects in residential buildings in Victoria to be 4% of the contract value. On the other hand, provision of adequate training and education to the tradespersons can reduce the quality problems associated with poor workmanship. Thus, the inclusion of certain prescriptive requirements in the Victorian Domestic Building Contracts Act which require tradespersons to pass necessary tests and obtain certificates of competency could help to decrease construction defects related to workmanship. The presence of incomplete items in a building is also found to be the second major causes of defects. Georgiou et al. (1999) found that the proportion of incomplete items was about 29% of the total defects. Nonetheless, strict supervision could alleviate construction defects due to incomplete items. This could be done by enacting regulations which oblige contractor's licence and supervisor's certificate holders to check the tradesperson's work strictly and to take responsibility for the defects due to the negligence of the licence holders. Hence, similar to NSW Home Building Act 1989, the Victorian Domestic Building Contracts Act 1995

needs Clauses which stipulate the duties of the licence and certificate holders as well as the associated penalty for non-compliance with the provisions of the Act.

CONCLUSION

This research conducted the systematic review of the literature and identified the journals which frequently publish articles addressing defects in buildings. It also analysed the contribution of the authors who are involved in conducting the research on building defects. Previous studies show that poor workmanship and incomplete building items are two main problems which could lead to defects in residential buildings in Victoria. However, improving the skill and education of the tradesperson and supervisors as well as having strict supervision during the building construction phase could mitigate construction and latent defects. One means of establishing the stringent quality control and supervision practices is by incorporating stringent requirements which address the certification of tradesperson or supervisor and licencing of contractors involved in residential building construction projects.

For the purpose of this study, the Domestic Building Contracts Acts of two states in Australia, NSW and Victoria, were reviewed and holistically evaluated. Accordingly, the Victorian Domestic Building Act 1995 did not explicitly address the issues related to issuance of tradesperson and supervisor certificates whereas the NSW Home Building Act 1989 stipulates the requirement for obtaining the certificates, the duties and, responsibilities of the licence or certificate holders, and the associated penalty for contravening the provisions of the Act. The authors suggested that lessons can be learnt from the NSW Home Building Act while revising the Victorian Domestic Building Contracts Act.

Hence, to potentially mitigate defects in residential buildings in Victoria, it is recommended that the regulatory body needs to include Sections which oblige the holders of builder's licence and supervisor's certificate to supervise the works executed by the tradesperson before covering up of each item of works during the domestic building construction phase. Furthermore, the authors suggest that all the tradesperson involved in building construction need to be certified after passing the examination and the practical tests prepared by the relevant authority.

REFERENCES

ABS (2017a) *Building Activity, Australia, Mar 2017*. Cat. no. 8752.0, Canberra, Australia.

ABS (2017b) *Construction Work Done, Australia, Preliminary*. Cat. no. 8755.0, Canberra, Australia.

Assaf, S., Al-Hammad, A.-M. and Al-Shihah, M. (1996) Effects of faulty design and construction on building maintenance. *Journal of performance of constructed Facilities*, 10 (4), 171-174.

Atkinson, A. R. (1999) The role of human error in construction defects. *Structural Survey*, 17 (4), 231-236.

AWCI (2017) *The Economic Benefits of Licensing Building and Construction Finishing Trade Contractors in Australia* [Online]. Association of Wall and Ceiling Industries (AWCI). Available: http://www.builderscollective.org.au/wp-content/uploads/2017/03/Build-Better-Benefits-from-Licensing-Finishing-Trade-Contractors.docx [Accessed 4 September 2017].

Carretero-Ayuso, M. J., Moreno-Cansado, A. and Cuerda-Correa, E. M. (2015) Research and analysis on recurring anomalies in foundations and structures. *Journal of Performance of Constructed Facilities*, 30 (3), 04015037.

Chew, M. (2005) Defect analysis in wet areas of buildings. *Construction and Building Materials,* 19 (3), 165-173.

Chew, M. and Tan, S. (2004) A multivariate approach to maintenance prediction of wet areas. *Construction Management and Economics,* 22 (4), 395-407.

Chong, W.-K. and Low, S.-P. (2005) Assessment of defects at construction and occupancy stages. *Journal of Performance of Constructed facilities,* 19 (4), 283-289.

Correia, J. R., Ferreira, J. and Branco, F. A. (2006) A rehabilitation study of sandwich GRC facade panels. *Construction and Building Materials,* 20 (8), 554-561.

Del Solar, P., Del Río, M., Villoria, P. and Nadal, A. (2015) Analysis of Recurrent Defects in the Execution of Ceramic-Coatings Cladding in Building Construction. *Journal of Construction Engineering and Management,* 142 (4), 04015093.

Forcada, N., Macarulla, M., Gangolells, M., Casals, M., Fuertes, A. and Roca, X. (2012a) Posthandover housing defects: sources and origins. *Journal of Performance of constructed facilities,* 27 (6), 756-762.

Forcada, N., Macarulla, M. and Love, P. E. (2012b) Assessment of residential defects at post-handover. *Journal of construction engineering and management,* 139 (4), 372-378.

Georgio, J. (2016) *Legislative Control and the Quality of Housing in Victoria.* PhD Thesis, The University of Melbourne.

Georgiou, J. (2010) Verification of a building defect classification system for housing. *Structural Survey,* 28 (5), 370-383.

Georgiou, J., Love, P. and Smith, J. (1999) A comparison of defects in houses constructed by owners and registered builders in the Australian State of Victoria. *Structural Survey,* 17 (3), 160-169.

Government of NSW (2016) Home Building Act 1989 No 147. Sydney, Australia.

Government of Victoria (2016) Domestic Building Contracts Act 1995. Melbourne, Australia.

Government of Victoria (2017) Building Act 1993 Version No.110. Melbourne, Australia.

Johnsson, H. and Meiling, J. H. (2009) Defects in offsite construction: timber module prefabrication. *Construction Management and Economics,* 27 (7), 667-681.

Josephson, P.-E. and Hammarlund, Y. (1999) The causes and costs of defects in construction: A study of seven building projects. *Automation in construction,* 8 (6), 681-687.

Lo, Y., Leung, W. and Cui, H. (2005) Roof construction defects of medium-rise buildings in sub-tropical climates. *Structural Survey,* 23 (3), 203-209.

Mills, A., Love, P. E. and Williams, P. (2009) Defect costs in residential construction, *Journal of Construction Engineering and Management,* 135 (1), 12-16.

Mills, A., Williams, P., Yu, D. and Australia, D. L. (2010) Benchmarking Construction Rework in Australian Housing. *International Journal for Housing Science and Its Applications,* 34 (3), 207.

Mohd-Noor, Z., Che-Ani, A. I., Sulaiman, Z., Abd-Razak, M. Z. and Tawil, N. M. (2016) Condition Monitoring Framework Based on the Cause of Mosque Physical Defects in Kuala Lumpur and Putrajaya. *Journal of Performance of Constructed Facilities,* 30 (5), 04016031.

Olubodun, F. and Mole, T. (1999) Evaluation of defect influencing factors in public housing in the UK. *Structural Survey,* 17 (3), 170-178.

Sommerville, J. (2007) Defects and rework in new build: an analysis of the phenomenon and drivers. *Structural Survey,* 25 (5), 391-407.

SYSTEMS THINKING AND MODELLING IN INNOVATIVE HOUSING

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Abstract
It is generally accepted, that implementation of innovation in housing not only provides homeowners with more affordable homes, and enable developers to build more cost-effective houses; but also affects national economic growth, energy consumption, and a broad range of environmental issues to name a few. This study addresses the decision making process within the complex innovation process in the construction sector by employing a systems modelling process aiming to conceptualise and formulate a systems model. The model aims to adopt a multidimensional view on the links between various factors related to innovation diffusion within construction and housing development. The model structure highlights that developers, architects and end-users, along with decision makers need to acknowledge innovative solutions as a priority in order to achieve the benefits of high-level innovation performance. The results suggest that housing construction sector requires assistance and support from the government in order to accumulate innovation capabilities and endure existing impediments such as lack of financial incentives. Hence, it is important to manage the significant factors related to housing policy making and public policy interventions that affect success in construction innovation. These results can assist decision makers in implementing various innovation planning strategies for future construction and housing development.

Keywords: Systems thinking; Systems modelling; Innovation; Housing; Decision making.

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INTRODUCTION

Housing affordability depends on many factors such as cost of land and building materials, available resources and government support. Construction materials, building methods and techniques have been changing significantly over time. Those changes mostly occur due to innovation processes in the housing construction industry. Innovations may improve what homes are made of and how they are built. As a result, houses may become more affordable. First of all, innovations in housing enable to build more-desirable homes at lower cost. It is a major driver for improving energy efficiency, reducing waste and keeping construction processes more sustainable. In other words, innovative solutions provide homeowners with more for less. Active innovation diffusion also assists governments in addressing major challenges related to housing affordability (Hassell et al., 2003; Miozzo and Dewick, 2004; Suprun and Stewart, 2015).

This article addresses the development and deployment of innovations within the construction industry. It is generally accepted, that construction and developing firms have limited openness to external knowledge and process development as a result of low levels of investment in new knowledge, which, subsequently, leads to relatively low levels of innovative capability and innovation performance (Suprun et al., 2016). The study aims to investigate the relationships among factors related to innovation diffusion within construction and housing development in order to improve the industry's innovative capabilities. There is a range of systems modelling techniques that allow modellers and decision makers to conceptualise and formulate a systems model that can aid interpretation of the complex cause-and-effect relationships, along with feedback mechanisms within a particular process (Maani and Cavana, 2007). By analysing the interdependencies in the industry's collaboration with the government and academia the research outcomes allow decision makers to take decisions which are based on a systems analysis capable of representing highly complex and dynamic innovation-related situations in the housing construction industry.

For the purposes of this study it was not enough to formulate and run a simulation model by using only desktop studies in order to support issues concerning innovation problems. Hence, stakeholders were involved in the analytic modelling process to ensure that they facilitate effective decision making. Participants included researchers and academic staff, decision makers from private and public construction companies, contractors, developers and public authorities' representatives.

METHODS

Systems thinking techniques have been applied to this research for the analysis of non-linear complex innovation diffusion process within the construction industry. The overarching goal of the chosen approach is to look at the bigger picture of the problem under study, build a conceptual model, and set up a base for the further simulation-based systems modelling. In other words, it is important to present the problem as a system of interrelated elements and investigate the system as a whole in order to reveal potential pathways to rational decision-making along with potential policy recommendations regarding the problem solving. Systems thinking is also a framework that determines to a great extent how the system components behave. It is a way of thinking holistically about problems while focusing on the elements and relations within the system under investigation (Maani and Cavana, 2007).

One of the most common ways to represent conceptual systems models is the use of Causal Loop Diagrams (CLD). A CLD is a tool for mapping a set of systematic relationships forming the complex system and used to create a further systems model for numerical simulations. It reveals the systemic structures underlying a complex system

consisting of key variables which affect the system's behaviour and outcomes. The interrelations between variables are crucial in the system interpretation as they define the system's dynamics. CLDs clarify the causality between system elements and help to trace the cause–effect relationships between them. Moreover, CLDs consist of both quantitative (hard) and qualitative (soft) variables (Suprun et al., 2016).

In a CLD, the variables are linked together by arrows that indicate a causal relationship, direct influence or change between them. Each causal link represents a polarity, either positive (+) or negative (-) to indicate changes. A positive polarity means that if the independent variable (cause) increases, the dependent variable (effect) increases too, and if the cause decreases, the effect will decrease. A polarity link means that if the independent variable (cause) increases, the dependent variable (effect) decreases, and if the cause decreases, the effect will increase, and vice versa (Maani and Cavana, 2007).

A combination of multiple links between variables collectively develops a loop. A loop polarity can also be determined as a reinforcing (R) or balancing (B) feedback process. A reinforcing (positive) loop accelerates change within a system and, as a result, causes the system to grow or decline exponentially, while a balancing (negative) loop counteracts change within a system to produce stabilising behaviour and drives the system towards equilibrium. The polarity between two variables can change over time and under varying conditions. This is due to the nonlinear nature of most complex systems.

RESULTS AND DISCUSSION

As mentioned previously, many factors are involved in complex innovation systems. The list of the system's components identified through literature review was approved by experts and stakeholders. Then, together with experts, the conceptual model in a form of a CLD was built using a rigorous and comprehensive analysis of the different factors involved. The CLD diagram reveals the systemic relationships and provides a broad vision of interactive factors that are part of the complex housing and construction innovation process. Interactions of variables are supported by experts that provide a high degree of reliability.

A representation of the problematic situation of innovation diffusion within the housing construction sector is illustrated in Figure 1. Eight main feedback loops emerged from the formulated CLD representing involvement of multiple actors in the innovation process (Table 1).

The relationships among the variables are dominated by reinforcing loops. Within the system, reinforcing processes can be helpful for improving the innovation performance in the construction industry in order to develop affordable houses.

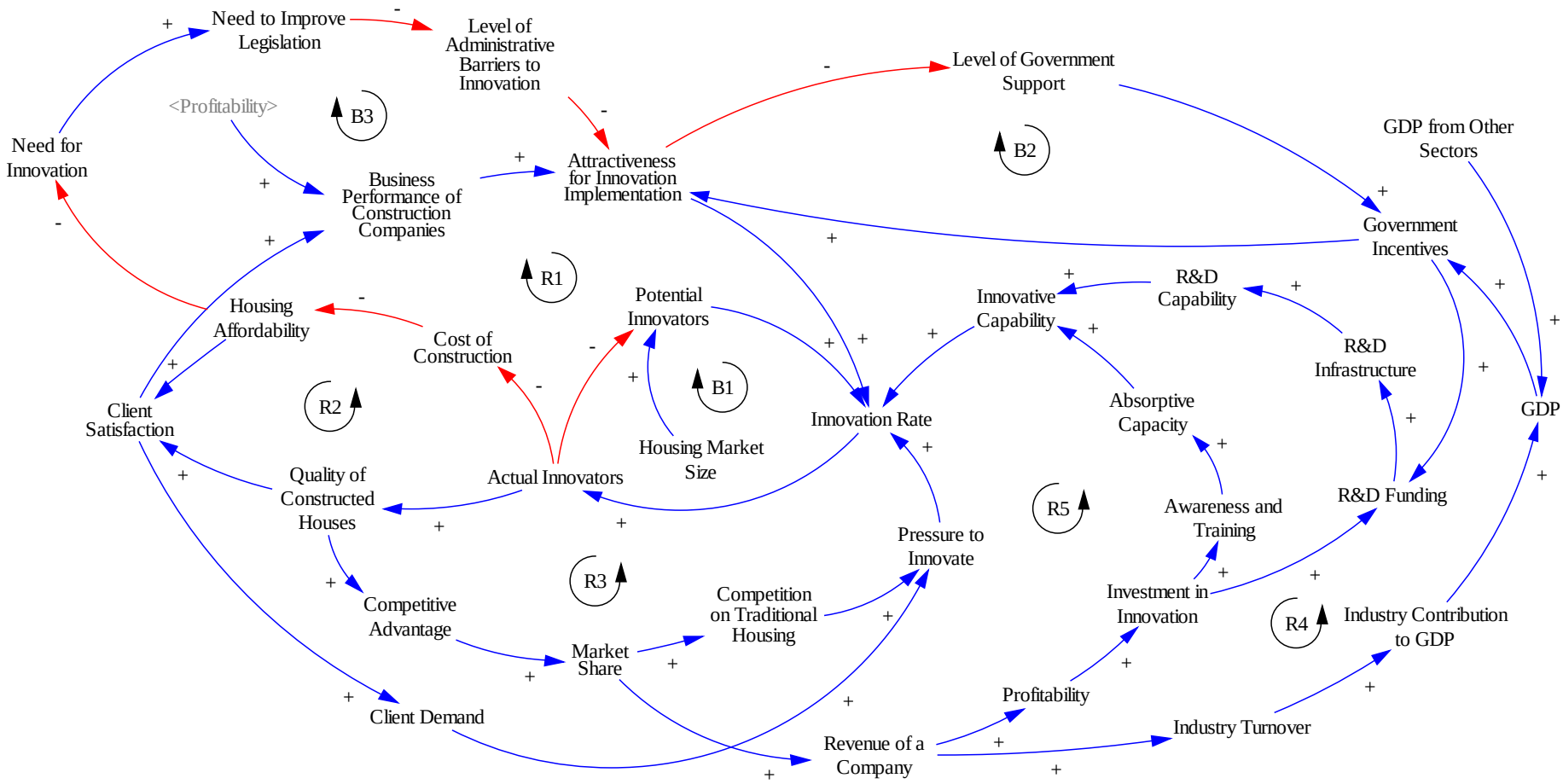

Figure 1. Causal loop diagram representing innovation diffusion in the housing construction industry

Table 1. Summary of feedback loops

Feedback loops	Loop name	Structure	Key message
B1	Market saturation	Potential innovators → Innovation rate → Actual innovators → Potential innovators	Growth of innovators is limited to the market size
R1	Industry motivation	Innovation rate → Actual innovators → Quality of constructed houses → Client satisfaction → Business performance of construction companies → Attractiveness for innovation implementation → Innovation rate	Increase in industry's willingness to innovate due to improving business performance
B2	Support for innovation	Attractiveness for innovation implementation → Level of government support → Government incentives → Attractiveness for innovation implementation	Necessity of additional support in order to promote innovation processes in housing
B3	Need for innovation	Need for innovation → Need to improve legislation → Level of administrative barriers to innovation → Attractiveness for innovation implementation → Innovation rate → Actual innovators → Cost of construction → Housing affordability → Need for innovation	Reducing regulatory burden to improve housing affordability situation
R2	Demand-driven pressure to innovate	Housing affordability → Client satisfaction → Client demand → Pressure to innovate → Innovation rate → Actual innovators → Cost of construction → Housing affordability	Client requirements to introduce innovative solutions
R3	Competitive pressure to innovate	Actual innovators → Quality of constructed houses → Competitive advantage → Market share → Competition on traditional housing → Pressure to innovate → Innovation rate → Actual innovators	Increasing competitiveness among developers and construction companies
R4	Government's role	Market share → Revenue of a company → Industry turnover → Industry contribution to GDP → GDP → Government incentives → R&D funding → R&D infrastructure → R&D capability → Innovative capability → Innovation rate → Actual innovators → Quality of constructed houses → Competitive advantage → Market share	Building innovative capability through government involvement
R5	Industry's role	Innovation rate → Actual innovators → Quality of constructed houses → Competitive advantage → Market share → Revenue of a company → Profitability → Investment in innovation → Awareness and training → Absorptive capacity → Innovative capability → Innovation rate	Building innovative capability through industry involvement

According to the group discussions with stakeholders and previously conducted studies (Suprun and Stewart, 2015), the following factors make decision-makers within housing and construction to acknowledge innovation implementation as a priority process to improve the efficiency of the industry and support housing affordability:

- Attractiveness for innovation implementation;
- Pressure to innovate;
- Innovative capability.

Innovations have to be attractive and there is a need to create an environment where innovative organisations are able to maintain high-tech business. Many studies recognise innovation as a factor that directly increases a firm's performance (Dansoh et al., 2017, Panuwatwanich et al., 2009). Use of innovative materials and technology enable companies to improve the quality of their products and services, reduce cost and time of construction works, and, as a result, make constructed houses more affordable. The innovation implementation leads to quality improvement and as a result an increase in client satisfaction as ones of the most essential industry drivers (*R1: Industry motivation*). However, at the initial stage innovation costs may be significant and make it hard for firms to compete (Seaden, and Manseau, 2001). As a result, insufficient industry's innovative activity takes place. Hence, the government may intervene by applying appropriate incentive schemes and promotions in order to increase the attractiveness of innovation and research investments, boost the economic interest of firms and stimulate innovation diffusion (*B2: Support for innovation*). By receiving such support, the industry is able of developing its capabilities gradually and receiving high profits. Unlike efficient support and high business performance, conservative and outdated construction-related legislation, rules, and building codes, may significantly hinder the innovation process (Gann et al., 1998; Suprun and Stewart, 2015). Consequently, a perceived need for innovation arising due the housing affordability problems makes governments to take measures aimed at improving current legislation and simplifying administrative procedures (*B3: Need for innovation*).

Clients, whether homeowners, private customers or government agencies, may significantly influence the industry's decision regarding innovation preferences by demanding more active use of innovative and sustainable applications, building materials and affordable resources. Satisfying the clients' needs and demands is highly conducive for innovation (*R2: Demand-driven pressure to innovate*). High competition in the market forces decision-makers within the housing construction industry to consider innovation implementation as a priority. It is generally accepted that companies gain a competitive advantage by introducing innovative solutions and adopting new technology (Miozzo and Dewick, 2002, Stewart, 2007). By improving the quality of constructed houses along with more affordable prices due to the use of innovation, a contractor may significantly increase its competitive advantage in the market. As a result, it reinforces the pressure on companies dealing with building traditional houses to invest more in cutting-edge ideas and R&D to stay afloat (*R3: Competitive pressure to innovate*).

Additionally, a firm's success in implementing innovative solutions depends on companies' capabilities as the process of transferring ideas into the end-product or service may become extremely complicated and costly, whether it is an organization giving preference to adopting new technology and developing methods for its improvement, or companies investing in R&D for introducing and implementing product and process innovations that are new to the industry or market (Hampson et al., 2014). In fact, construction organisations do not innovate in isolation as isolation hinders the knowledge generation process. The government as a policy-maker can significantly influence the R&D progress by implementing encouraging incentive schemes, policies and relevant award programs (*R4:Government's role*). As a result, industry readiness for industry-academia collaboration achieves a higher level along with gradually declining industry isolation. As previously mentioned, innovation implementation makes the industry more efficient and profitable which in turn drives economic growth and motivates the

government to promote innovation to provide further absorption and application of R&D results. Subsequently, these connections build a robust foundation to the further development of public universities and research centres following by greater need for government involvement. Nevertheless, the industry itself needs to be integrated in the R&D collaborations required for effective implementation of technology-using strategies and research commercialisation. Once companies start investing in qualified personnel and training of the professionals, their innovative capability increases followed by successful innovation implementation and, as a result, higher investments to be taken on innovative processes and practices (*R5: Industry's role*).

CONCLUSIONS

The paper aimed to build a conceptual systems model as a foundation for a simulation model. The chosen systems thinking technique integrated with stakeholder engagement in the formulation of the conceptual model may be considered as a decision making platform for the innovative housing sector.

The research findings suggest that housing construction sector requires assistance and support from the government in order to accumulate innovation capabilities and endure existing impediments such as lack of financial incentives. Hence, it is important to manage the significant factors related to housing policy making and public policy interventions that affect success in construction innovation.

Further work is associated with developing a running simulation dynamic model in order to reveal potential strategic pathways to overcome innovation diffusion challenges and encourage construction of affordable houses.

REFERENCES

Dansoh, A., Oteng, D. and Frimpong, S. (2017) Innovation development and adoption in small construction firms in Ghana. *Construction Innovation*, 17**,** 511-535.

Gann, D.M., Wang, Y. and Hawkins, R. (1998) Do regulations encourage innovation? The case of energy efficiency in housing. *Building Research and Information*, 26(5), 280-296.

Hampson, K., Kraatz, J. A. and Sanchez, A. X. (2014) *R&D Investment and Impact in the Global Construction Industry*. Taylor & Francis.

Hassell, S., Wong, A., Houser, A., Knopman, D. and Bernstein, M.A. (2003) *Building Better Homes: Government Strategies for Promoting Innovation in Housing.* RAND Corporation, Santa Monica, CA.

Maani, K. E. and Cavana, R. Y. (2007) *Systems Thinking, System Dynamics: Managing Change and Complexity.* Prentice Hall, Auckland, N.Z.

Miozzo, M. and Dewick, P. (2002) Building competitive advantage: innovation and corporate governance in European construction. *Research Policy*, 31**,** 989-1008.

Miozzo, M. and Dewick, P. (2004) Networks and Innovation: sustainable technologies in Scottish social housing. *R&D Management*, 34(3), 323-333.

Panuwatwanich, K., Stewart, R. A. and Mohamed, S. (2009) Critical pathways to enhanced innovation diffusion and business performance in Australian design firms. *Automation in Construction*, 18**,** 790-797.

Seaden, G. and Manseau, A. (2001) Public policy and construction innovation. *Building Research and Information*, 29**,** 182-196.

Stewart, R. A. (2007) IT enhanced project information management in construction: Pathways to improved performance and strategic competitiveness. *Automation in Construction*, 16**,** 511-517.

Suprun, E., Sahin, O., Stewart, R. and Panuwatwanich, K. (2016). Model of the Russian Federation construction innovation system: An integrated participatory systems approach. *Systems,* 4**,** 29.

Suprun, E. V. and Stewart, R. A. (2015) Construction innovation diffusion in the Russian federation. *Construction Innovation,* 15(3)**,** 278-312.

AUSTRALIAN BANK MORTGAGE INTEREST RATE PASS-THROUGH: DOES INTERNATIONAL FUNDING COST MATTER?

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Abstract
This study examines heterogeneous interest-rate pass-through for Australian banks, relating the cost-of-funds rates to owner-occupied housing rates on weekly bank-level data from January 1997 to December 2015. The cash rate and the bank bill swap rate act as the proxies for bank funding costs, domestically and internationally. The nonlinear autoregressive distributed lag approach (Shin, Yu, & Greenwood-Nimmo 2014) is employed to investigate heterogeneous asymmetry in the pass-through. The results highlight the substantial asymmetry in the transmission of both bank funding rates. In the long run, banks are more responsive to passing on increases in the funding costs into their mortgage rates than to passing on the cost cuts. We also find evidence of the short-term asymmetries for several banks. Our findings confirm that bank mortgage rate setting is significantly affected by international funding costs, apart from the cash rate. This study provides several important policy implications.

Keywords: Asymmetry; interest-rate pass-through; bank mortgages; NARDL model

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INTRODUCTION

The interest rate channel plays a vital role in monetary policy transmission for the economies implementing the inflation targeting regime, especially Australia. Changes in policy rates substantially influence not only retail and housing interest rates, but also house prices (Robstad 2018), with ultimate impact on consumption, investment, and the real economy. The Australian mortgage market is one of the top five global markets that their mortgage credit ratios to GDP are greater than 100 percent. Its size reached $1,614.27 billion of the household credit in February 2018, larger than the value of the listed equity market. In this area owner-occupied housing loans constitute two-third of the total, equivalent to 60 percent of GDP (author's calculation from APRA 2017; ABS 2017a, b). The effectiveness of the housing interest rate transmission therefore is of great interest to banking regulators, policy makers, and the public. The 2008 global financial crisis (GFC) has vitalized publicity surrounding bank mortgage pricing behaviour. The huge extent of media coverage and political interest related to mortgage interest rate movement provides a clear indication of this issue's importance.

The study of interest rate pass-through examines how fast and how large banks adjust their retail interest rates corresponding to a unit change in a policy rate or a market rate. Housing interest rates, based on the marginal cost pricing model by De Bondt (2005), are priced as a markup over bank marginal funding cost. The literature on interest rate pass-through (IRPT) typically adopts either a monetary policy approach (MPA) or a cost-of-funds approach (CFA) (Sander & Kleimeier 2004). The former analyses the transmission of the policy rate to retail interest rates (e.g., Apergis & Cooray 2015; Lim, Tsiaplias, & Chua 2013; Sathye 2013), while the latter examines the pass-through from a market rate, either of a maturity similar to the average maturity of loans, or the most correlated with loan rates (De Bondt 2005; De Graeve, De Jonghe, & Vennet 2007). Commonly, a policy rate or a money market rate is used to be the proxy for bank marginal funding cost. Bank interest rates were confirmed to stably align with policy rates and/or money market rates prior to the GFC. The alignment of policy, market and loan rates has been impaired since the GFC in Australia (Lim et al. 2013; Sathye 2013), or in the euro area (Aristei & Gallo 2014; Hristov, Hülsewig, & Wollmershäuser 2014). The transmission breakdown has raised major concerns about the efficacy of the IRPT mechanism in an increased risky environment (Cifarelli & Paladino 2016; Lim et al. 2013).

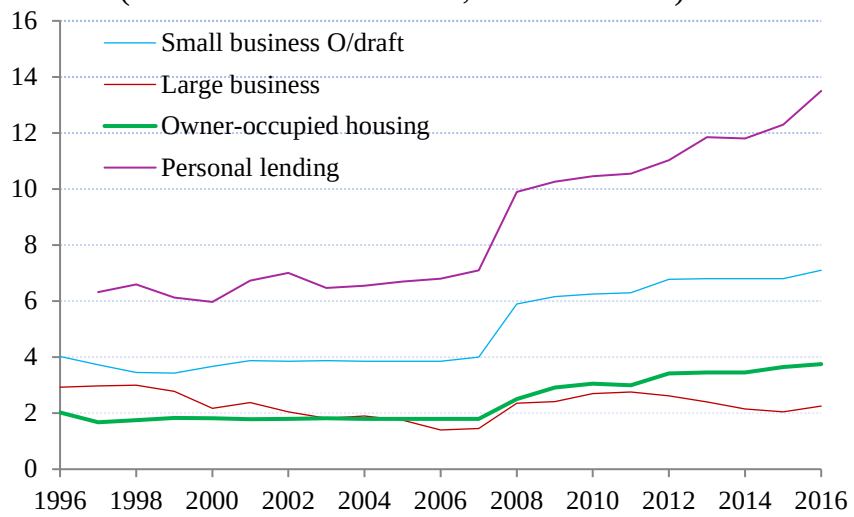


Figure 1. Spreads of the bank lending rates over the cash rate. Source: RBA (2017) "Statistics, Tables F1, 2, 5".

Australia has recently experienced upward trends in spreads of bank interest rates over the cash rate, while the synchronous declines in absolute terms of the rates have gradually occurred since 2008 (see Figure 1). Valadkhani (2013) documents the empirical evidence of a significant upward shift of mortgage rate spreads over cash rate for the 23 Australian lenders since the GFC. Increases in these spreads are typically interpreted to indicate changes in bank pricing behaviour, but this view may be biased. The GFC has given rise to the cost of borrowing in world financial markets, unfavourably affecting Australian lenders. A controversy has surrounded the heavy reliance of banks on foreign liabilities and its impact on their lending setting practices and financial stability (Bailey, Uffelen, & Wood 2012; Berkelmans & Duong 2014; Stewart, Robertson, & Alexandra 2013; Turner & Nugent 2015). These prior papers highlight the existence of the connection between the cost of international funds and mortgage interest rates. However, they are all in the forms of descriptive studies, no systematic empirical studies have yet investigated this link. This paper sheds new light on the literature supporting asymmetric pricing of housing interest rates by answering two questions, whether the international funding cost affects the mortgage rate transmission, and what is the nature of that relationship.

This study provides a scientific investigation of the relationships between mortgage interest rates and both domestic and international funding costs. The nonlinear autoregressive distributed lag (NARDL) approach (Shin et al. 2014) is employed to analyse a bank-level dataset obtained commercially from 20 anonymous Australian lenders, which providing approximately 90 percent of the total outstanding mortgages. The testable hypothesis about mortgage funding cost is theoretically based on the marginal cost pricing model by De Bondt (2005) and Beau, Hill, Hussain, & Nixon (2014). Bank funding costs are portioned into three key components, a risk free rate, a risk premium and other costs. The cash rate is the direct measure of the risk free rate. The remainders are determined by bank-specific characteristics, debt instruments and macroeconomic factors. Banks raise funds from a wide variety of sources, retail deposits, wholesale funding and the bank's capital base. Australian banks' offshore wholesale funding is the second largest component of total liabilities, accounting for around 20–30 percent, just below retail deposits at nearly 60 percent during the last decade (Wilkins, Gardner, and Chapman 2016). Australian banks also hold a globally prolonged position in using foreign funds, around 35 percent, to fund their mortgages (Turner and Nugent 2015). In line with this decomposition, the foreign funds rate is a possible measure of marginal wholesale funding costs for Australian banks.

The novelty of this paper is threefold. First, this study provides the source of the divergence between the cash rate and mortgage rates which should be valid for mortgage markets with significant shares of international funds in the bank funding. Second, this paper contributes to the extension of the literature by using a novel weekly bank-specific dataset to examine the asymmetric transmission for Australian banks. Third, for each lender the empirical results of this study provide solid evidence for the simultaneous presence of their "size asymmetry" in three dimensions, impact, short-run, and long-run. Previous studies (e.g., De Haan & Sterken 2011; Valadkhani 2013) mainly identified positive and negative deviations from the equilibrium path in their short-run dynamic models without modelling the size of the long-term asymmetry. This study discloses the fully extent of asymmetric adjustments between mortgage rates and bank funding costs, both cash rate and foreign fund rate.

The remainder of this paper is organised as follows. Section 2 outlines the method, while Section 3 describes the data. Results are discussed in Section 4 and Section 5 draws key conclusions.

THEORETICAL AND EMPIRICAL MODELS

The marginal cost pricing model by De Bondt (2005) and Freixas and Rochet (2008) is the key framework in determining how interest rates are transmitted under imperfect market competition.[1] A bank interest rate is approximated as a constant markup over the marginal cost of funds as follows:

$$br = \beta mr + \mu \tag{1}$$

where *br* and *mr* are the bank interest rate and the cost-of-funds rate. A constant markup (μ) and the size of the long-term pass-through coefficient (β) reflect the effectiveness of the transmission and have positive signs. β tends to be incomplete but close to unity when adjusting to the equilibrium.

Financial institutions operating in weakly competitive markets or in oligopolistic market segments are likely to have an incentive to incompletely pass on market interest rate changes to their retail rates because they are somewhat more powerful in price setting, vice and versa (Hannan & Berger 1991). This market power hypothesis has been largely confirmed, for example, in the UK market by Fuertes and Heffernan (2010), in the UK, US, and Australian mortgage markets by Apergis & Cooray (2015). Switching and adjustment costs hypothesis theorises about asymmetry that these high costs make borrowers stick with their existing financial products and/or lenders, resulting in a weaker competitive market. Subsequently, lenders can exert their pricing power to profit from their customers. Rocha (2012) posits that differences in switching costs, inadequate access to information, lacking alternative sources of consumer financial products, and encountering higher search costs lead to a lower personal loan price elasticity, resulting in the rigidity of the personal lending rates in Portugal.

We use the NARDL approach by Shin et al. (2014) to identify asymmetry in the mortgage rate pass-through for the individual banks. The NARDL model has extensively applied in financial economic studies owing to its notable advantages. This method overcomes major drawbacks of the conventional cointegration techniques by modelling jointly asymmetries and cointegration dynamics in a single equation, and releasing the nonstationary assumption. Both short-term and long-term asymmetries are simultaneously captured in the NARDL setting, while the conventional techniques enable researchers to estimate asymmetries in the adjustment speed only. By decomposing the exogenous variables into positive and negative partial sums, the NARDL model is able to accurately differentiate between nonlinear cointegration, linear cointegration, the absence of cointegration. The NARDL model is therefore avoids omitting hidden cointegration.[2] Importantly, this model enables for observing asymmetric adjustment paths and/or duration of disequilibrium in a graphical presentation of cumulative dynamics multiplier effects without modelling the asymmetric error correction parameter. By accommodating heterogeneous asymmetries on impact, in the short term and in the long term, the NARDL model has instantly ideally become researchers in pass-through study.

The NARDL model requires the partial sum decomposition of the cost-of-funds rates:

$$mr_t^+ = \sum_{j=1}^{t} \Delta\, mr_j^+ = \sum_{j=1}^{t} \max(\Delta mr_j\,, 0),\;\; mr_t^- = \sum_{j=1}^{t} \Delta mr_j^- = \sum_{j=1}^{t} \min(\Delta mr_j\,, 0) \tag{2}$$

where $mr_t = mr_0 + mr_t^+ + mr_t^-$ and mr_t is either BB_t or CR_t in this analysis. These partial sum processes divide funding cost rises, mr_t^+, and funding cost cuts, mr_t^-. The

[1] This model is based on the mark-up pricing contribution of Rousseas (1985)

[2] Hidden cointegration exists if two time series are not cointegrated in the conventional sense, but their positive and negative components are cointegrated (Granger & Yoon 2002).

initial value mr_0 can be set to 0. An asymmetric long-run IRPT relationship in Eq. (1) is formalised as

$$br_t = \beta^+ mr_t^+ + \beta^- mr_t^- + u_t \tag{3}$$

where asymmetric long-run parameters are β^+ and β^- and the stationary zero-mean error process u_t indicates the deviations of bank mortgage rate from its long-run equilibrium. The NARDL(p,q) model for the effective mortgage rate changes faced by bank i at time t is obtained by embedding Eqs. (2) and (3) within an ARDL(p,q)

$$\Delta br_t = \mu + \rho br_{t-1} + \delta^+ mr_{t-1}^+ + \delta^- mr_{t-1}^- + \sum_{j=1}^{p-1} \lambda_{i,j}\, \Delta br_{t-j} + \sum_{j=0}^{q-1} (\pi_j^+ \Delta mr_{t-j}^+ + \pi_j^- \Delta mr_{t-j}^-) + \varepsilon_t \tag{4}$$

where all variables are as defined above. The maximum number of 12 lags for both p and q is used to select the optimal number of lags (p, q) based on the lowest values of the information criteria. Δ is the first different operator and ρ is the error correction term. The long-run asymmetry parameters of BB and CR are given by $\beta_i^+ = -\delta_i^+/\rho_i$ and $\beta_i^- = -\delta_i^-/\rho$. The impacts and short-run responses to increases and decreases in BB_t and CR_t are the significant coefficients in the vector $(\pi_{i,0}^+, \dots, \pi_{i,q-1}^+, \pi_{i,0}^-, \dots, \pi_{i,q-1}^-)'$. The NARDL model produces unbiased long-term coefficients and their inferences even in the presence of weakly endogenous nonstationary explanatory variables. These coefficients are theoretically positive, while short-term parameters can be either positive or negative because many factors can simultaneously affect the transmission at the funding cost shocks.

The Shin et al. (2014) bootstrap testing is implemented to plot the cumulative dynamic multiplier effect of a unit change in mr_t^+ and mr_t^- on br_t. These cumulative dynamic multipliers ascertain the evolution of the effective mortgage rates over the horizons h = 0, 1, …, H in response to a unit increase and decrease respectively of the cost-of-funds rates in period h=0. The combination of these positive and negative cumulative dynamic multipliers therefore measures the IRPT asymmetry at horizon h and can be recursively obtained from Eq. (4):

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial br_{t+j}}{\partial mr_t^+}, \quad m_h^- = \sum_{j=0}^{h} \frac{\partial br_{t+j}}{\partial mr_t^-} \quad with\ h = 0, 1, 2, \dots \tag{5}$$

Note that as $h \to \infty$, then $m_h^+ \to \beta_i^+$, and $m_h^- \to \beta_i^-$ hence, the dynamic multipliers represent the traverse from the short run to the long run.

SAMPLE AND DATA

An 18-year time span from 1st January 1997 to 31st December 2015 is selected owing to its economic importance. First, this period covers a full mortgage boom with a surge in outstanding mortgage debt as a percentage of GDP from nearly 30 percent in 1997 to 105 percent in Dec 2016 (Author's calculation from database of APRA 2017; ABS 2017a, b). Second, the primary regulatory reforms, the establishments of the APRA, Wallis Inquiry, and inflation targeting framework, were formally implemented and endorsed. Third, the sample spans extreme financial distress, the 2007-collapse of the UK and US mortgage lenders, the ensuing GFC, and the sovereign debt crisis, allowing for capturing potential market structural changes.

A novel bank-level dataset of weekly effective interest rates on variable home-loans is created from 20 anonymous commercial banks. The banks provide approximately 90 percent of the total outstanding mortgages over the sample period (author's calculation). The selected sample thus is relatively well represented. The 20 out of the total 37

sampling banks after screening comprise four major and 13 smaller Australian-owned banks, and three foreign-owned subsidiaries. The major banks create the oligopoly of the banking system with the predominance of mortgage market share at 85 percent (author's calculation). It is thus expected to be heterogeneous mortgage price-setting practices.

The effective home-loan rate variable, ER_t, is constructed from the annual adjustable percentage rate of mortgages that covers all kinds of fees, synthesised into the motion "mortgage rate". The mortgage rates were commercially obtained from Cannex's survey of Australian lenders. Two weekly exogenous funding variables are retrieved from Bloomberg DataStream. The official cash rate, CR_t, that is the interest rate paid on overnight funds, is a driving force of the overall cost of banks' funding because its alteration signals changes in market interest rates, subsequently changes in the cost of domestic borrowings for banks (Wilkins et al. 2016). The cash rate after vigorous cuts since October 2008 in response to the GFC is now on hold at its historic low of 1.5 percent, but still well above extremely low policy rates, which are close to zero (Canada, the UK, the US, and non-Eurozone countries) or negative (Denmark, Eurozone area, Japan, Sweden, and Switzerland). The 3-month A$ bank bill swap rate (BBSW) acts as the proxy for the foreign funds rate variable, BB_t. The BBSW is usually consulted when Australian banks issue their foreign funds, both onshore and offshore, while the US$ LIBOR is a benchmark rate for offshore issues only (Guttmann and Rodgers, 2015; RBA, 2006). Technically, using the BBSW eliminates possible calculation errors from currency converting. In this study, using the BBSW as the proxy for international funding costs is more appropriate.

RESULT ANALYSIS

Table 1 presents the asymmetric results of the NARDL estimations, using the foreign funds rate variable. Table 2 exhibits the estimated coefficients using the cash rate variable. In each table, Panel A, B and C report, for respectively, the estimated mortgage rate coefficients for individual banks in major, foreign and region groups. The first four columns reveal long-term asymmetry, whereas the consecutive columns display short-term asymmetry and diagnostics. The bound test results, both t_{TDM} and F_{PSS} validate the presence of cointegration between mortgage rates and the foreign funds rate, but fail to confirm that relationship with the cash rate. Most estimates pass the serial correlation test, suggesting the well-specified NARDL model.

Table 1. Asymmetry results of the foreign funds rate by NARLD Eqn. (4).

NARLD(p, q)	(a) Long-run asymmetry				(b) Short-run asymmetry						(c) Diagnostics		
	SoA (ρ)	Long-run IRPT		W_{LR} H_o:	Impact IRPT		W_{ISR} H_o:	Cumulative IRPT		W_{CSR} H_o:	t_{BDM}	F_{PSS}	χ^2_{SC}
		β^+	β^-	$\beta^+ = \beta^-$	π_0^+	π_0^-	$\pi_0^+ = \pi_0^-$	$\sum_{j=0}^{1}\pi_j^+$	$\sum_{j=0}^{1}\pi_j^-$	$\sum_{j=0}^{1}\pi_j^+ = \sum_{j=0}^{1}\pi_j^-$			
Panel A: Major banks													
ERM1(10,3)	-0.064***	0.850***	0.796***	81.81***	0.022	0.227***	–	0.218***	0.450***	10.268***	-6.188***	13.594***	1.786
	(0.010)	(0.040)	(0.037)	[0.000]	(0.046)	(0.035)				[0.000]	[0.000]	[0.000]	[0.087]
ERM2(10,3)	-0.078***	0.859***	0.806***	88.70***	0.188***	0.310***	3.375*	0.308***	0.541***	7.303***	-6.255***	14.375***	0.176
	(0.011)	(0.039)	(0.035)	[0.000]	(0.049)	(0.039)	[0.067]			[0.007]	[0.000]	[0.000]	[0.951]
ERM3(10,3)	-0.093***	0.908***	0.826***	180.83***	0.241***	0.353***	1.587	0.241***	0.456***	6.257**	-7.472***	19.162***	2.103
	(0.012)	(0.032)	(0.028)	[0.000]	(0.063)	(0.047)	[0.208]			[0.013]	[0.000]	[0.000]	[0.123]
ERM4(10,3)	-0.107***	0.882***	0.808***	184.26***	0.217***	0.228***	0.017	0.217***	0.388***	4.182**	-8.186***	23.203***	1.729
	(0.012)	(0.029)	(0.025)	[0.000]	(0.059)	(0.042)	[0.897]			[0.041]	[0.000]	[0.000]	[0.189]
Panel B: Foreign banks													
ERF1(11,7)	-0.037***	0.931***	0.864***	37.72***	0.196***	0.100***	0.700	0.779***	0.716***	0.264.	-5.622***	11.960***	1.482
	(0.009)	(0.054)	(0.049)	[0.000]	(0.051)	(0.042)	[0.403]			[0.608]	[0.000]	[0.000]	[0.218]
ERF2(10,3)	-0.044***	0.844***	0.785***	37.80***	0.287***	0.073	–	0.287***	0.316***	0.023	-5.809***	11.598***	1.012
	(0.008)	(0.057)	(0.052)	[0.000]	(0.054)	(0.045)				[0.879]	[0.000]	[0.000]	[0.410]
ERF3(10,3)	-0.035***	0.873***	0.792***	54.46***	0.127***	0.107***	0.239	0.303***	0.388***	0.787	-4.848***	9.092***	2.265
	(0.007)	(0.073)	(0.066)	[0.000]	(0.048)	(0.040)	[0.625]			[0.375]	[0.000]	[0.000]	[0.079]
Panel C: Region banks													
ER8(10,7)	-0.044***	0.941***	0.914***	8.397***	0.290***	0.041	_	0.641***	0.699***	1.352	-4.409***	7.149***	1.369
	(0.010)	(0.009)	(0.009)	[0.004]	(0.055)	(0.045)				[0.245]	[0.000]	[0.000]	[0.190]
ER9(10,7)	-0.083***	0.991***	0.887***	226.30***	0.237***	0.027	_	0.486***	0.800***	0.288	-6.067***	13.926***	1.354
	(0.016)	(0.014)	(0.013)	[0.000]	(0.061)	(0.046)				[0.592]	[0.000]	[0.000]	[0.222]
ER10(11,7)	-0.036***	0.912***	0.845***	38.06***	0.132***	0.197***	0.098	0.616***	0.908***	0.056	-4.258***	7.363***	1.547
	(0.010)	(0.008)	(0.008)	[0.000]	(0.050)	(0.042)	[0.754]			[0.813]	[0.000]	[0.000]	[0.213]

ER11(11,7)	-0.077***	0.944***	0.866***	109.60***	0.181***	0.176***	0.045	0.555**	0.659***	4.596**	-7.021***	17.314***	1.559
	(0.015)	(0.013)	(0.012)	[0.000]	(0.061)	(0.047)	[0.832]			[0.032]	[0.000]	[0.000]	[0.124]
ER12(10,7)	-0.047***	0.832***	0.775***	35.81***	0.047	-0.043	_	0.520**	0.676**	0.293	-5.227***	9.671***	0.693
	(0.011)	(0.008)	(0.008)	[0.000]	(0.060)	(0.049)				[0.588]	[0.000]	[0.000]	[0.760]
ER13(10,7)	-0.043***	0.939***	0.864***	56.51***	0.121**	0.020	_	0.598**	0.777***	1.903	-5.135***	10.352***	1.324
	(0.010)	(0.008)	(0.008)	[0.000]	(0.052)	(0.044)				[0.168]	[0.000]	[0.000]	[0.228]
ER14(11,7)	-0.036***	0.907***	0.838***	41.42***	0.188***	0.039	_	0.700***	0.690***	0.384	-5.265***	10.682***	1.126
	(0.010)	(0.008)	(0.007)	[0.000]	(0.049)	(0.041)				[0.536]	[0.000]	[0.000]	[0.325]
ER15(10,7)	-0.082***	0.909***	0.888***	8.024***	0.130**	0.344***	6.565**	0.711**	0.845**	0.286	-5.837***	11.689***	0.609
	(0.018)	(0.015)	(0.015)	[0.005]	(0.059)	(0.049)	[0.011]			[0.593]	[0.000]	[0.000]	[0.610]
ER16(10,7)	-0.027***	0.913***	0.856***	16.78***	0.160***	0.024	_	0.670**	0.735***	0.443	-3.829**	5.465**	1.549
	(0.008)	(0.007)	(0.006)	[0.000]	(0.047)	(0.039)				[0.506]	[0.000]	[0.001]	[0.213]
ER17(10,7)	-0.033***	*1.065****	0.956***	27.15***	0.100	0.018	_	0.845**	0.883***	2.483	-3.103	3.777	1.511
	(0.011)	(0.011)	(0.010)	[0.000]	(0.065)	(0.050)				[0.116]	[0.002]	[0.011]	[0.210]
ER18(10,7)	-0.012**	0.639***	0.505**	9.544***	0.074	0.064	_	0.753***	0.716***	0.011	-2.564	2.908	1.612
	(0.006)	(0.004)	(0.004)	[0.002]	(0.058)	(0.048)				[0.916]	[0.011]	[0.034]	[0.098]
ER19(11,7)	-0.045***	0.881***	0.816***	54.08***	0.170***	0.187***	0.085	0.753**	0.677***	0.008	-4.482***	7.136***	1.692
	(0.011)	(0.009)	(0.008)	[0.000]	(0.053)	(0.044)	[0.770]			[0.930]	[0.000]	[0.000]	[0.167]
ER20(9,7)	-0.016**	0.793***	0.762***	0.599	0.114	0.200***	–	0.405**	0.626**	0.024	-3.189	4.215*	1.519
	(0.007)	(0.005)	(0.005)	[0.439]	(0.069)	(0.053)				[0.878]	[0.002]	[0.006]	[0.112]

(1) Table 1 exhibits the results of the optimal NARDL estimates for the responsiveness of the mortgage rates to foreign funds rate changes for each bank of the three sampled groups in the corresponding panels. (2) The estimated long-run coefficients $\beta^{+}$and β^{-} are associated with increases and decreases in the cost-of-funds rate variable (in italics if equal to unity), defined by $\beta_i^{+} = -\delta_i^{+}/\rho_i$ and $\beta_i^{-} = -\delta_i^{-}/\rho$. (3) The parameters $\pi_0^{+}$and π_0^{-} measure the impact pass-through reflected in the same week as the cost-of-funds rate shock; and cumulative short-run dynamics are $\sum_{j=0}^{1}\pi_j^{+}$ *and* $\sum_{j=0}^{1}\pi_j^{-}$. (4) W_{LR} is the Wald statistics for the long-run asymmetry, W_{ISR} and W_{CSR} correspond to the Wald F-statistics for the contemporaneous and cumulative short-run asymmetry, respectively. (5) SoA is the average speed of the adjustment coefficient. (6) t_{BDM} and F_{PSS} are the *t*- and *F*-statistics of the Bound test for cointegration. The t_{BDM} (Banerjee et al. 1998) tests the single restriction H_0: $\rho_i = 0$ against the alternative H_{A}: $\rho_i < 0$. The F_{PSS} (Pesaran et al. 2001) tests the null hypothesis of no cointegration H_0: $\rho_i = \delta_i^{+} = \delta_i^{-} = 0$ against the alternative of cointegration H_{A}: $\rho_i \neq \delta_i^{+} \neq \delta_i^{-} \neq 0$.Critical values for the BDM *t*-test and the PSS *F*-test are, for respectively, – 4.1 (1%), – 3.53 (5%), – 3.21 (10%) and – 6.36 (1%), – 4.85 (5%), – 4.14 (10%). (7) Standard errors and *p*-values are given in brackets and parentheses; the asterisks ***, **, and * denote significance at the 1, 5, and 10% levels, respectively.

Table 2. Asymmetry results of the cash rate by NARLD Eqn. (4).

NARLD(p,q)	(a) Long-run asymmetry				(b) Short-run asymmetry						(c) Diagnostics		
	SoA (ρ)	Long-run IRPT		W_{LR} H_0: $\beta^+ = \beta^-$	Impact IRPT		W_{ISR} H_0: $\pi_0^+ = \pi_0^-$	Cumulative IRPT		W_{CSR} H_0: $\sum_{j=0}^{1}\pi_j^+ = \sum_{j=0}^{1}\pi_j^-$	t_{BDM}	F_{PSS}	χ^2_{SC}
		β^+	β^-		π_0^+	π_0^-		$\sum_{j=0}^{1}\pi_j^+$	$\sum_{j=0}^{1}\pi_j^-$				
Panel A: Major banks													
ERM1(10,6)	-0.008	*1.385****	*1.035****	4.660**	0.891***	0.675***	32.402***	1.845***	1.657***	5.975**	-1.094	1.714	1.141
	(0.007)	0.439	0.290	[0.031]	(0.034)	(0.021)	[0.000]			[0.015]	[0.274]	[0.163]	[0.332]
ERM2(10,6)	-0.020*	*1.079****	0.834***	20.429***	0.308***	0.133***	11.598***	1.701***	1.641***	0.283	-1.998	1.849	1.931
	(0.010)	(0.129)	(0.088)	[0.000]	(0.045)	(0.025)	[0.000]			[0.595]	[0.046]	[0.137]	[0.129]
ERM3(10,6)	-0.042***	*1.157****	0.834***	132.584***	0.216***	-0.024	–	1.788***	1.626***	5.393**	-3.523*	5.399**	0.816
	(0.012)	(0.057)	(0.035)	[0.000]	(0.046)	(0.025)				[0.020]	[0.000]	[0.001]	[0.634]
ERM4(10,6)	-0.036**	*1.190****	0.858***	53.455***	0.169***	0.003	–	2.206***	1.974***	3.199*	-2.472	4.969**	1.041
	(0.014)	(0.090)	(0.051)	[0.000]	(0.050)	(0.026)				[0.074]	[0.014]	[0.007]	[0.374]
Panel B: Foreign banks													
ERF1(11,6)	-0.012	*1.372****	*1.002****	5.357**	0.222***	0.085***	6.325**	2.314***	2.001***	5.241**	-1.286	2.044	2.647
	(0.009)	(0.396)	(0.249)	[0.021]	(0.051)	(0.032)	[0.012]			[0.013]	[0.199]	[0.106]	[0.104]
ERF2(10,6)	-0.008	*1.415***	0.980***	2.559	0.292***	0.080**	12.043***	1.988**	1.776**	1.597	-1.105	1.575	0.966
	(0.008)	(0.526)	(0.307)	[0.110]	(0.055)	(0.033)	[0.001]	1.439***	1.132***	[0.207]	[0.270]	[0.194]	[0.476]
ERF3(10,6)	-0.012*	*1.177****	0.809***	13.830***	0.062	0.031	–			8.640***	-1.919	2.108	11.372
	(0.007)	(0.214)	(0.141)	[0.000]	(0.047)	(0.028)				[0.003]	[0.055]	[0.098]	[0.001]
Panel C: Region banks													
ER8(10,6)	-0.032***	*0.999****	0.900***	6.755***	0.322***	0.114***	9.054***	2.095***	1.522***	12.41***	-2.799	2.688	1.583
	(0.012)	(0.012)	(0.011)	[0.009]	(0.061)	(0.036)	[0.003]			[0.000]	[0.005]	[0.045]	[0.107]
ER9(10,6)	-0.058***	*1.227****	0.858***	173.30***	0.180***	-0.032	–	2.066***	1.741***	5.851**	-4.727***	8.687***	1.382
	(0.017)	(0.020)	(0.014)	[0.000]	(0.058)	(0.032)				[0.016]	[0.000]	[0.000]	[0.176]
ER10(11,6)	-0.009	*1.463***	*1.034****	2.751*	0.277***	0.099***	9.050***	2.365***	2.343***	0.741	-1.396	2.106	9.840
	(0.010)	(0.009)	(0.007)	[0.098]	(0.049)	(0.029)	[0.003]			[0.390]	[0.163]	[0.098]	[0.002]
ER11(11,6)	-0.066***	*1.124****	0.841***	138.60***	0.040	0.000	–	1.740***	1.747***	0.015	-4.054**	7.286***	1.692
	(0.017)	(0.018)	(0.014)	[0.000]	(0.059)	(0.031)				[0.902]	[0.000]	[0.001]	[0.134]
ER12(10,6)	-0.039***	0.971***	0.757***	37.79***	0.017	-0.037	–	1.030***	1.169***	0.212	-4.160***	5.956**	1.586
	(0.011)	(0.011)	(0.009)	[0.000]	(0.068)	(0.041)				[0.646]	[0.000]	[0.000]	[0.106]

ER13(10,6)	-0.032***	*1.129****	0.840***	49.68***	0.082	0.035	–	1.561***	1.601***	0.111	-3.947**	6.091**	1.567
	(0.011)	(0.011)	(0.008)	[0.000]	(0.053)	(0.033)				[0.739]	[0.000]	[0.000]	[0.111]
ER14(11,6)	-0.017*	*1.143****	0.849***	14.67***	0.068	0.059*	–	1.850***	1.728***	1.807	-1.359	1.386	3.247
	(0.010)	(0.010)	(0.008)	[0.000]	(0.051)	(0.030)				[0.179]	[0.174]	[0.246]	[0.039]
ER15(10,6)	-0.007	1.483	*1.037***	0.350	0.325***	0.092**	11.280***	2.452***	2.387**	0.679	-0.262	0.843	4.904
	(0.015)	(0.015)	(0.013)	[0.555]	(0.057)	(0.038)	[0.001]			[0.410]	[0.794]	[0.471]	[0.027]
ER16(10,6)	-0.016*	*1.108****	0.838***	9.241***	0.018	0.005	–	1.776***	1.706***	0.336	-1.918	2.350	11.592
	(0.008)	(0.008)	(0.006)	[0.002]	(0.051)	(0.031)				0.563	[0.055]	[0.071]	[0.001]
ER17(10,6)	-0.016*	*1.308****	0.930***	17.85***	0.032	-0.022	–	1.951***	1.488***	15.92***	-1.257	1.333	0.627
	(0.009)	(0.012)	(0.008)	[0.000]	(0.051)	(0.028)				[0.000]	[0.209]	[0.264]	[0.535]
ER18(10,6)	-0.011**	0.499*	0.132	8.763***	-0.063	0.001	–	1.296***	1.054***	1.774	-3.032	5.648**	0.676
	(0.005)	(0.005)	(0.003)	[0.003]	(0.064)	(0.038)				[0.183]	[0.003]	[0.001]	[0.776]
ER19(11,6)	-0.014	*1.185****	0.863***	9.315***	0.324***	0.090***	14.544***	2.241***	1.954***	5.968**	-1.207	1.411	1.806
	(0.010)	(0.010)	(0.008)	[0.002]	(0.053)	(0.032)	[0.000]			[0.015]	[0.228]	[0.238]	[0.165]
ER20(9,6)	-0.014**	0.777***	0.666***	0.742	0.188**	-0.012	–	1.041**	0.933***	1.546	-2.364	1.890	0.631
	(0.007)	(0.006)	(0.005)	[0.389]	(0.074)	(0.039)				[0.214]	[0.018]	[0.130]	[0.817]

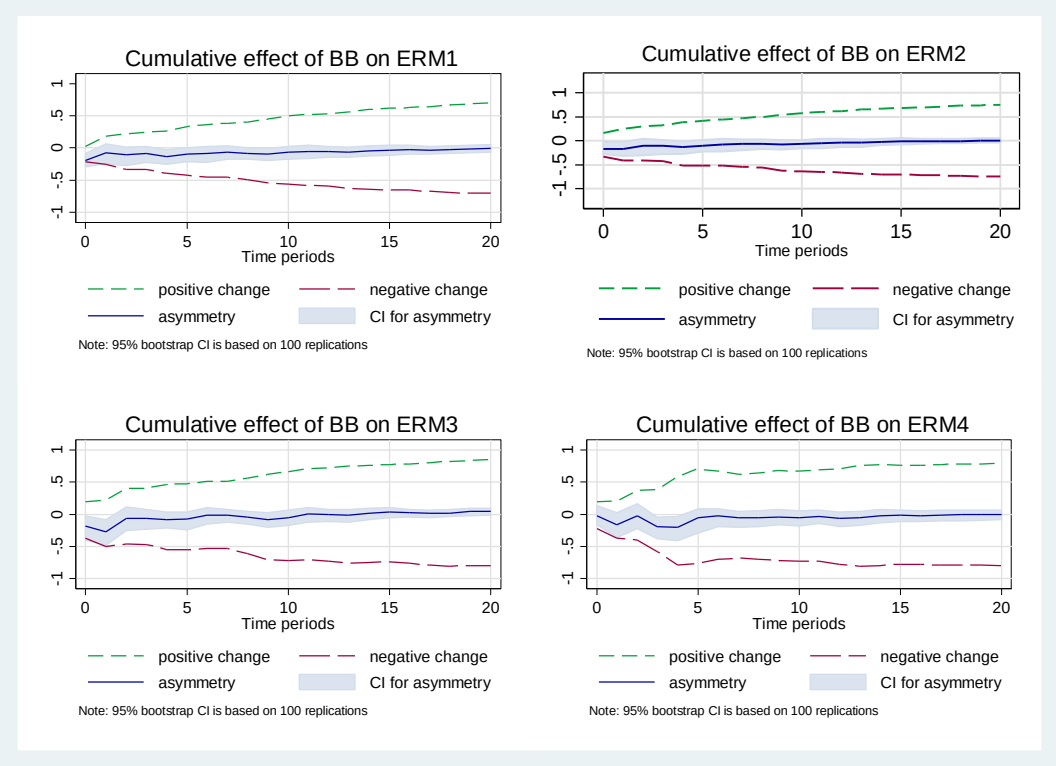
(1) This table reveals the results of the optimal NARDL estimations for the responsiveness of the mortgage rates to cash rate changes each bank of the three sampled groups in the corresponding panels. (2) The remainders are similar to Table 1.

We first analyse the long-run asymmetry in the foreign-funds rate transmission. The adjustment speed is individually negative and highly significant for all estimates, validating a long-term cointegration between mortgage rates and the foreign funds rate for each bank. The positive and negative long-run coefficients associated with increases and decreases in the foreign funds rate are all highly significant at the 1% level and have correct signs, signifying a direct relationship. The long-run Wald results confirm the presence of the long-term asymmetry downwards for all banks, except one regional bank, coded ER_{20}, signifying a positive asymmetry. This finding is consistent with Apergis and Cooray (2015). The long-run effect in absolute values of the funding cost rises are more pronounced than that of the cost cuts for all bank mortgage rates, which is preferable to banks. This finding underpins the market power hypothesis for Australia.

The cash rate results are reported in Table 2. All Big-4 banks disclose asymmetric pricing conduct, while this behaviour presents in two out of three foreign subsidiaries, and ten out of 13 regional banks, validating that Australian banks asymmetrically adjust their mortgage rates corresponding to policy rate shifts. The asymmetric findings substantiate that in the long run, the mortgage interest rates are influenced mainly by increases in the cost-of-funds rates. All Big-4 among others reveal the lowest degrees of asymmetries, both positive and negative, indicating their strongest market power in mortgage pricing. These long-term magnitudes associated with funding cost rises and cuts are mostly close to unity for BB equations, and greater than one for CR estimations. This finding suggests that in the long run bank mortgage interest rates are comparatively responsive to funding cost changes, consistent with the existing literature. These asymmetric findings strongly validate the hypothesis of the oligopoly market.

The short-run asymmetry combines the instantaneous impact and cumulative asymmetry. These positive impacts associated with increases in funding costs are mostly highly significant at the 1% and 5% levels and have positive signs as expected, but those with regards to decreases are mostly insignificant and have both positive and negative signs. These coefficients can be positive and negative because at the time of the funding cost shock, bank price-setting can be affected by different factors. Positive impacts are much greater in size than negative impacts and wide variations in magnitudes exist in both positive and negative impact parameters. This result suggests that banks are more responsive to funding cost rises, but are quiet to immediately respond to cost cuts. Our downward sluggish and heterogeneous findings are consistent with Fuertes et al. (2010) regarding the UK mortgage market with the explanations for these negligible degrees of the negative impacts that are menu costs and bank-specific characteristics. The symmetry tests for impact dynamics of the foreign funds rate are virtually insignificant. Only one regional bank coded ER_{15} reveals the asymmetric impact of the foreign funds rate, whereas eight out of 20 banks immediately asymmetrically respond to cash rate shocks. This finding specifies a greater competition level in the wholesale funding market due to highly stringent market conditions compared with the domestic market.

a) Dynamic multipliers for the effective mortgage rate - foreign funds rate



b) Dynamic multipliers for the effective mortgage rate - cash rate

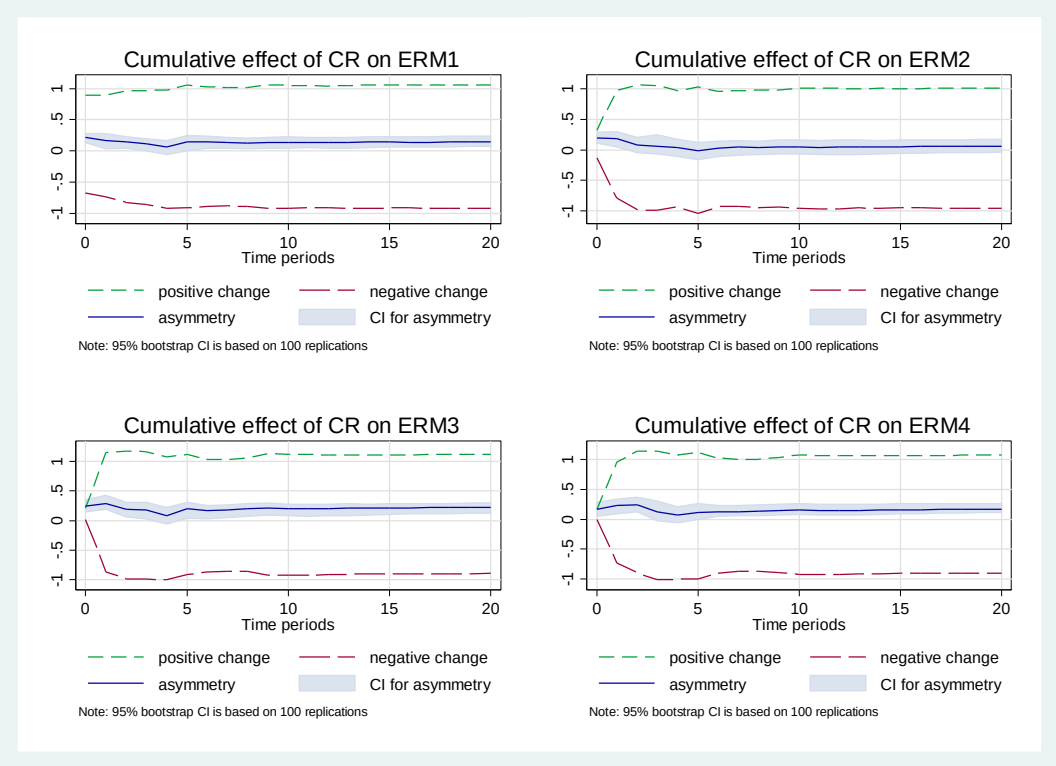
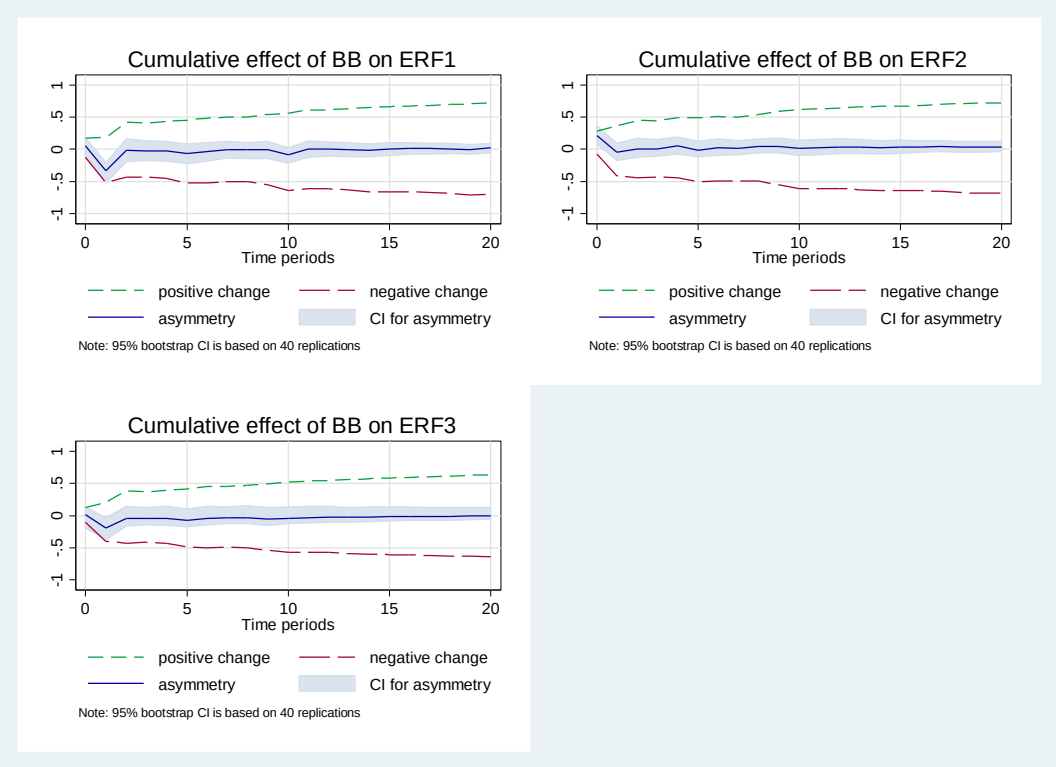


Figure 2. Dynamic multipliers for major-bank mortgage rates. This figure plots the cumulative dynamic multiplier effect of respectively a 1% increase or decrease of the cost-of-funds rates on the bank effective mortgage rates in percentage points on the vertical axis. Weekly intervals are on the horizontal axis.

a) Dynamic multipliers for the effective mortgage rate - foreign funds rate



b) Dynamic multipliers for the effective mortgage rate - cash rate

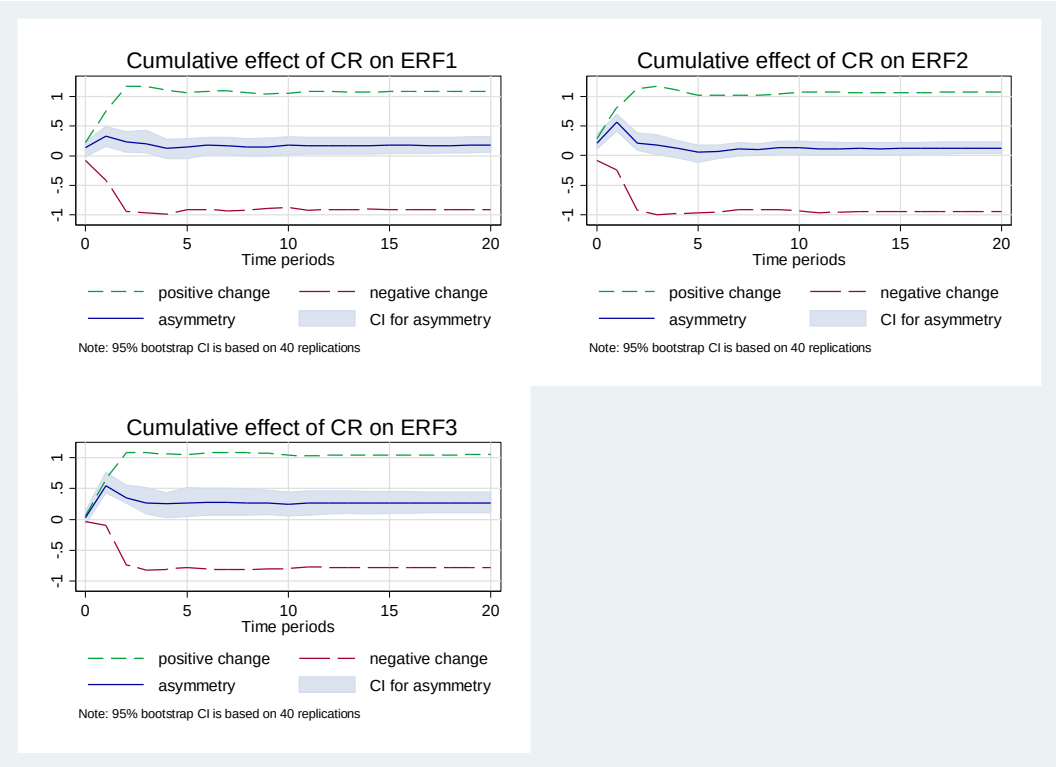


Figure 3. Dynamic multipliers for foreign-bank mortgage rates. The rest are similar to Figure 2.

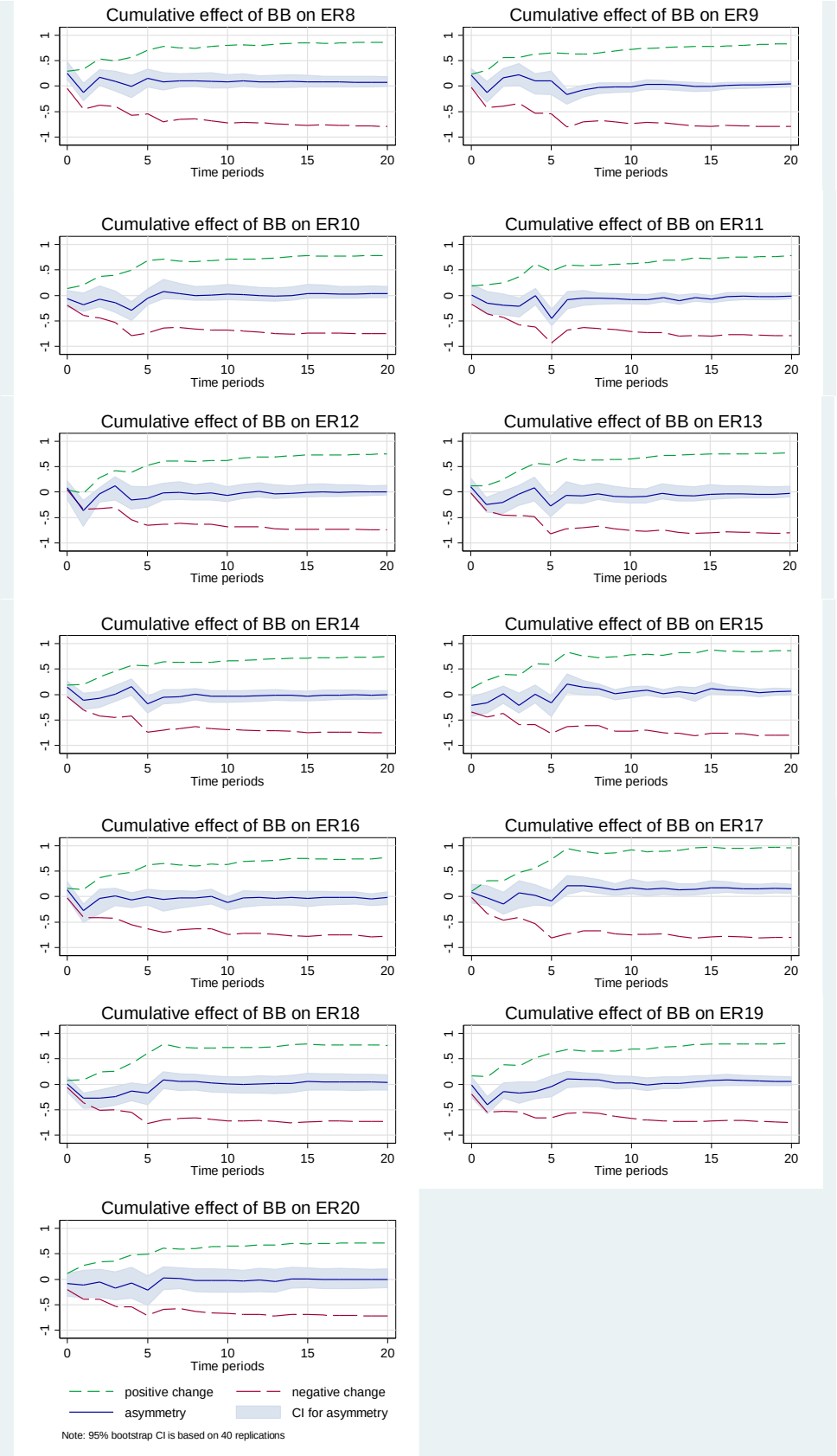


Figure 4. Dynamic multipliers for region-bank mortgage rates and the foreign funds rate.

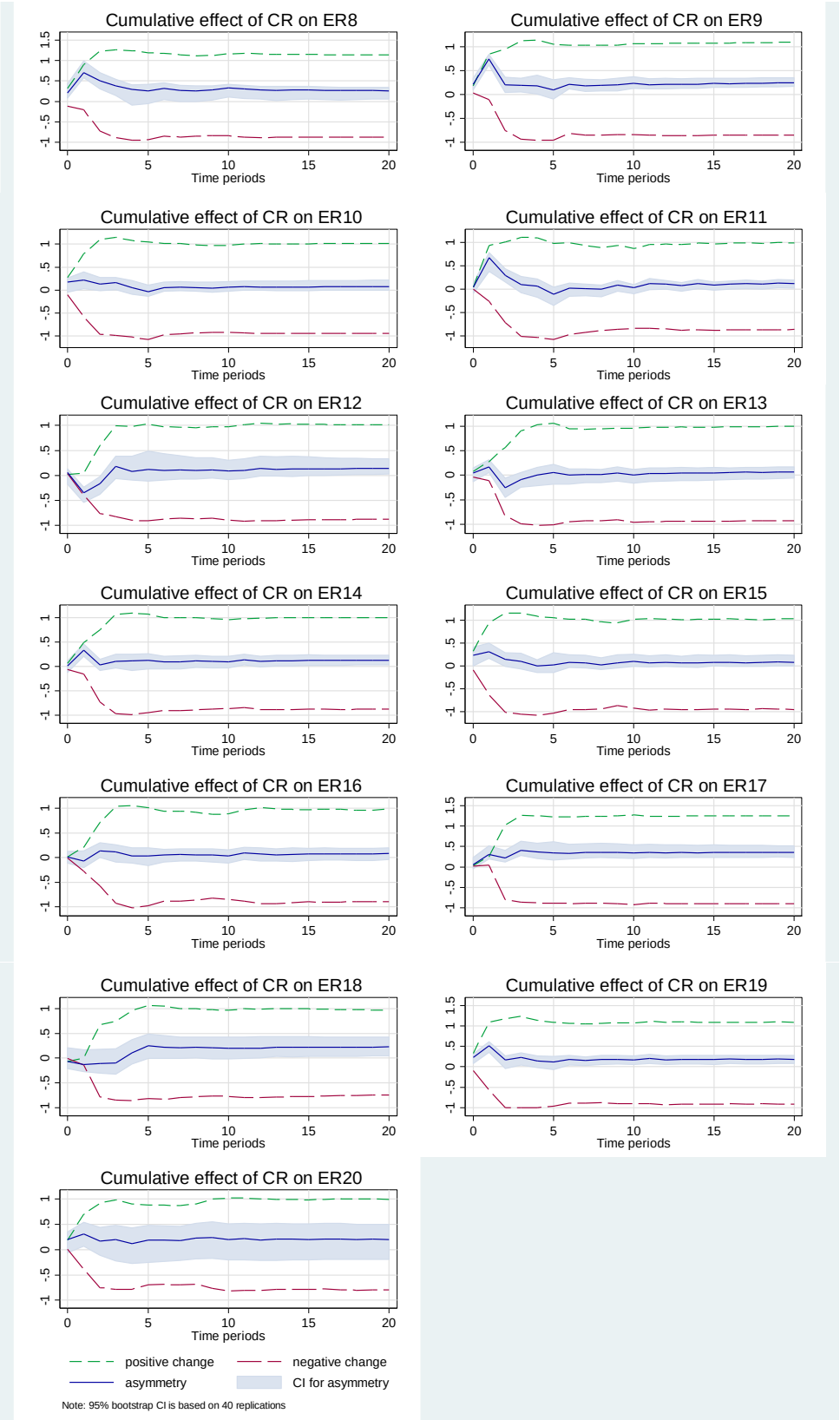


Figure 5. Dynamic multipliers for region-bank mortgage rates and the cash rate.

Figures 2 to 5 plot the cumulative dynamics of short-term asymmetry and heterogeneity in the mortgage rate pass-through for individual banks in corresponding

panels in Tables 1 and 2. We focus on four key findings and the plausibility. First, the cumulative asymmetry in the transmission of the cash rate exists in nine out of 20 banks, including three major banks. Only four majors reveal the asymmetry in their foreign funds rate transmission, indicating their most dominant position in mortgage financing. Second, great variations in pass-through degrees exist among the tested banks. The cash rate estimations provide the superior cumulative asymmetry in size at much greater than one, while that of the foreign funds rate is considerably smaller than one. These estimated results show clearer heterogeneity and wider variations in the bank-specific pass-through from cash rate rather than from international funding cost. Third, banks differently react to cash rate and foreign funds rate changes. They are all greater and faster to transmit cash rate rises to their mortgage rates than to pass on the rate cuts, resulting in a positive asymmetry. This finding is consistent with prior studies (e.g., Apergis and Cooray 2015; Valadkhani 2013). Interestingly, most banks respond to the foreign funds rate in the opposite direction with a negative asymmetry that is similar to De Haan and Sterken (2011). Our findings indicate the higher competitive pressure for banks in raising wholesale funds to finance their mortgages in the short term. Forth, all 13 smaller domestic-owned lenders among the sampled banks are the most responsive to increases and decreases in the cost-of-funds rates, both domestic and international. They have the highest magnitudes of the positive and negative multipliers and longer response intervals to the foreign funds rate, about 3–5 weeks, than to the cash rate, approximately 2 weeks. This finding validates their lowest market power and concludes that these banks are price-setting followers. In line with our expectation, the major and foreign banks are price makers, as shown in these figures; they are the most sluggish and unhurried to adjust their mortgage prices due to their market dominance, reconfirming the market concentration hypothesis.

This bank-specific study finds not only the long-run asymmetry in mortgage rate pass-through, but also the heterogeneous asymmetry and rigidity in the short run. These findings are highly consistent with the contemporary IRPT literature (Fuertes et al. 2010), indicating further work need to be done in determining what factors cause the heterogeneous asymmetry.

CONCLUSIONS

This study examined asymmetry in the transmission of the foreign funds rate and the cash rate to the mortgage rates for Australian banks over the 18-year period 1997:1–2015:12 using the NARDL model. The novel weekly bank-level dataset is constructed from the effective interest rates on variable home-loans of 20 anonymous commercial banks. By doing so, parallel estimates of the pass-through from changes in cash rate to mortgage rates, and the integration of the mortgage rate and foreign funds rate have been conducted.

The results suggest that Australian banks asymmetrically set their mortgage interest rates in heterogeneous manner. Short-term heterogeneity and rigidity in the mortgage rate pass-through are found for all estimates, both cash rate and foreign funds rate. The existence of the varied asymmetries across banks indicates significant disparities in mortgage rate setting. The long-term positive asymmetry is confirmed for both cash rate and foreign funds rate. The region group is the most competitive lenders with the highest pass-through magnitudes, while the Big-4 and foreign subsidiaries are market dominant. These findings reaffirm the oligopolistic market hypothesis for Australia. The asymmetry findings hence specify a stronger relationship between bank mortgage rates and international funding costs.

This work contributes to the IRPT literature with two important implications to monetary and financial stability perspectives. First, our findings provide convincing

evidence of the strong influence of foreign funding costs on mortgage rates. This empirical evidence is of practical use to the Australian Prudential Regulation Authority (APRA) and Reserve Bank of Australia (RBA) because of the increased integration of Australian mortgage financing with world financial markets. The outlook for economic growth and inflation can be shaped by the volatility of bank funding costs. Therefore, foreign funding cost that is integral to Australian banks' funding costs matters to the APRA and RBA for their micro-prudential and macro-prudential supervision. Second, the solid evidence of the positive asymmetry in the long term pass-through signals a series of consumer protection solutions that require the Australian Competition & Consumer Commission (ACCC) to implement. Banks have greatly passed on funding cost rises to their mortgage borrowers by setting higher rates on new lending, affecting consumer wellbeing directly and significantly because interest payments are nontax-deductible for home-loan borrowers. This pricing conduct over time could induce financial fragility because the higher costs of mortgage debt would increase the number of unaffordable borrowers subsequent to increased credit losses for banks.

REFERENCES

Apergis, N. and Cooray, A. (2015) Asymmetric interest rate pass-through in the U.S., the U.K. and Australia: New evidence from selected individual banks. *Journal of Macroeconomics*, 45, 155–172.

APRA. (2017) Monthly banking statistics. Australian Prudential Regulation Authority Publishing APRAWeb. http://www.apra.gov.au/adi/Publications/Pages/monthly-banking-statistics.aspx

Aristei, D. and Gallo, M. (2014) Interest rate pass-through in the Euro area during the financial crisis: A multivariate regime-switching approach. *Journal of Policy Modeling*, *36*, 273–295.

Australian Bureau of Statistics (ABS). (2017a) *Australian National Accounts: Finance and Wealth, Dec 2016 (5232.0)*. Canberra.

Australian Bureau of Statistics (ABS). (2017b) *Australian National Accounts: Housing Finance, May 2017 (5609.0)*. Canberra.

Bailey, O. Uffelen, L. Van, and Wood, K. (2012) International activities of Australian banks. *RBA Monthly Bulletin*, December, 47–56.

Banerjee, A. Dolado, J. and Mestre, R. (1998) Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of Time Series Analysis*, 19(3), 267–283.

Beau, E. Hill, J. Hussain, T. and Nixon, D. (2014) Bank funding costs: what are they, what determines them and why do they matter? *Bank of England: Quarterly Bulletin*, 54(4), 370–384.

Berkelmans, L. and Duong, A. (2014) Developments in banks' funding costs and lending rates. *RBA Monthly Bulletin*, March, 69–76.

Cifarelli, G. and Paladino, G. (2016) Time-varying mark-up and the ECB monetary policy transmission in a highly non linear framework. *International Review of Economics & Finance*, 45, 247–262.

De Bondt, G. J. (2005) Interest rate pass-through: Empirical results for the Euro area. *German Economic Review*, 6(1), 37–78.

De Graeve, F. De Jonghe, O. and Vennet, R. Vander. (2007) Competition, transmission and bank pricing policies: Evidence from Belgian loan and deposit markets. *Journal of Banking & Finance*, 31(1), 259–278.

De Haan, L. and Sterken, E. (2011) Bank-specific daily interest rate adjustment in the Dutch mortgage market. *Journal of Financial Services Research*, 39(3), 145–159.

Freixas, X. and Rochet, J.C. (2008) *Microeconomics of Banking* (2nd ed.). MIT Press, Cambridge.

Fuertes, A. Heffernan, S. and Kalotychou, E. (2010) How do UK banks react to changing central bank rates? *Journal of Financial Services Research*, 37(2), 99–130.

Granger, C. W. and Yoon, G. (2002) Hidden Cointegration. *University of California*, 2002–2, 1–48.

Guttmann, R. and Rodgers, D. (2015) International banking and liquidity risk transmission: Evidence from Australia. *IMF Economic Review*, 63(3), 411–425.

Hannan, T. H. and Berger, A. N. (1991) The rigidity of prices: Evidence from the banking industry. *The American Economic Review*, 81(4), 938–945.

Hristov, N. Hülsewig, O. and Wollmershäuser, T. (2014) The interest rate pass-through in the Euro area during the global financial crisis. *Journal of Banking & Finance*, 48, 104–119.

Lim, G. C. Tsiaplias, S. and Chua, C. L. (2013) Bank and official interest rates: How do they interact over time? *Economic Record*, 89(285), 160–174.

Pesaran, M. H. Shin, Y. and Smith, R. J. (2001) Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16, 289–326.

RBA. (2006) Australian banks' global bond funding. *RBA Monthly Bulletin*, August, 1–6.

Robstad, Ø. (2018) House prices, credit and the effect of monetary policy in Norway: evidence from structural VAR models. *Empirical Economics*, 54(2), 461–483.

Rocha, M. D. (2012) Interest rate pass-through in Portugal: Interactions, asymmetries and heterogeneities. *Journal of Policy Modeling*, 34, 64–80.

Rousseas, S. (1985) A markup theory of bank loan rates. *Journal of Post Keynesian Economics*, 8(1), 135–144.

Sander, H. and Kleimeier, S. (2004) Convergence in euro-zone retail banking? What interest rate pass-through tells us about monetary policy transmission, competition and integration. *Journal of International Money and Finance*, 23(3), 461–492.

Sathye, M. (2013) Financial crisis and interest rate pass-through in Australia. *Review of Pacific Basin Financial Markets and Policies*, 16(4), 1–22.

Shin, Y. Yu, B. and Greenwood-Nimmo, M. (2014) *Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework*. In: Sickles, R. and Horrace, W. (Eds) Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications. Springer, New York.

Stewart, C. Robertson, B. and Alexandra, H. (2013) Trends in the funding and lending behaviour of Australian banks. *Research Discussion Paper 2013/15*, Reserve Bank of Australia.

Turner, G. and Nugent, J. (2015) International linkages of the Australian banking system: Implications for financial stability. *The Finsia Journal of Applied Finance*, (3), 34–43.

Valadkhani, A. (2013) The pricing behaviour of Australian banks and building societies in the residential mortgage market. *Journal of International Financial Markets, Institutions and Money*, 26(1), 133–151.

Wilkins, K. Gardner, G. and Chapman, B. (2016) Developments in banks ' funding costs and lending rates. *RBA Monthly Bulletin*, March, 21–30.

FLUCTUATING REGIONAL HOUSE PRICE AFFORDABILITY AND THE IRRELEVANCE OF MORTGAGE RATES

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Abstract
Although house prices and wages are both influenced by distinct factors that shape their own evolutions, they are also intrinsically connected through house price affordability. Standard theory suggests that macroeconomic policies centred around adjustments in the mortgage rate are of prime importance in ensuring that the housing market does not overheat. This study contributes to the understanding of the link between housing market affordability and mortgage rates by investigating this association across regions of New Zealand. We show that the global financial crises affected regional house price affordability asymmetrically. Application of trajectory regressions to quarterly data between 2000-2017 also reveals only a limited connection between house price affordability and mortgage rates.

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INTRODUCTION

Housing affordability is recognised as a feature and increasingly problem for many cities around the globe (Voith and Wachter, 2009). The reasons for such concerns are in part the result of the exponential house price growth in urban areas since the turn of the century (Harvey, 2012). Extremes in housing affordability are often identified and measured by metrics such as high ratios of house prices and incomes (Murphy, 2014). For example, Demographia (2018) ranked unaffordability in cities in 2018 with the top-10 being Hong Kong with a Median Multiple of 19.4, Sydney (12.9), Vancouver (12.6), San Jose (10.3), Melbourne (9.9), Los Angeles (9.4), Honolulu (9.2), San Francisco (9.1), Auckland (8.8) and London (8.5). This article explores housing affordability across New Zealand, which includes the dominant housing market of Auckland ranked 9th in the world for unafforability.[1] Auckland has a dominant housing market in New Zealand and a good example of a single city that has a dominating influence over its wider national economy (Murphy, 2016).

The adequacy of housing supply to meet rising demands has become a national and regional problem in New Zealand and its housing crisis is exacerbated by increasing house prices which make them unaffordable. Available data show an annual increase of about 5.8% across urban regions, with median house price of around $550,000 nationally and $870,000 in Auckland. 70,000 more houses are needed to meet current shortfalls with more than half of these needed in Auckland and the New Zealand Government plans to build 100,000 good quality, affordable and healthy homes in the 10 years following 2018 (Johnson et al., 2018).

A dominant view in the macroeconomic literature is that house price growth is influenced by the mortgage rate and monetary policy more generally. Interest rates influence wage growth, patterns of spending and saving, decisions concerning the best assets to invest in. Housing stock in New Zealand has, over the last 10 years, been a relatively safe place to invest, and with rates of return in housing investments being on a par with or surpassing other investments and with pensions being cut in several countries due to austerity and poor performance in other financial assets, the demand for housing has grown.

Although house prices and wages are both influenced by distinct factors that shape their own evolutions, they are also intrinsically connected through house price affordability. Mortgage rates adjustments have been seen as a way to control and reduce the prevalence of overheating in the housing market. This article explores the associations between housing affordability, wage growth and mortgage rates across regions of New Zealand overt eh period 2000-2017. It questions the effectiveness of mortgage rates as a policy for controlling house price and wage growth. In the global economy when financial capital is relatively free to move and is attracted to assets that reward higher rates of returns, and in a time period that includes unsurpassed prosperity, global financial crisis and then slow global recovery, global political turmoil and increasing inequalities, investing in assets that are tangible and also provide other flows of income, such as healthy rental returns on housing ownership, can be viewed as a good substitute for intangible monetary assets. Incessant devotion to monetary policies, and particularly mortgage rates, to dampen house price growth may be misguided and ineffective under these circumstances.

[1] In other metrics, China had ten out of the 35 large and medium cities exceeding ten times income-price in 2007 (Kuang and Li, 2012).

In the next section we present a review that highlights how house prices and wages have an intrinsic connection with affordability. We then emphasise how macroeconomic monetary policies based around mortgage rates are thought to be able to dampen the housing market and influence affordability. Contextual information of the New Zealand housing market is also provided. The next sections provide details of the methodology and the data. Applications of trajectory analyses generate indications of the degree of similarity of regional house prices and reveal the degree of (ir)relevance of mortgage rates for different regional house price trajectories and the asymmetric impact of the global financial crises on house price affordability across New Zealand's regions since the millennium.

HOUSE PRICES, WAGES AND AFFORDABILITY

Affordability can have directional meaning, such as an improvement or decline by some monetary value. Value also has normative and positive meanings: in this normative sense it is where individuals and households ought to be able to purchase a certain property (Kuang and Li, 2012), and in a positive sense it is where empirical 'facts' may show affordability using some statistical correlation between say wages and property prices (Meen and Andrew, 2008). Measuring and quantifying methods of affordability are useful inroads into the understanding of affordability, and include ratios (income-house price), residuals (after housing costs have been subtracted from incomes) and costs (such as total housing costs) (Stone, 2006). Although these measures remain important, context and room for debate continue to be essential parts of the policy setting arena due to asymmetries and persistence in rates of affordability across time and space as well as the need for conceptual rigor to be balanced with practical policy considerations.

In the academic literature that explores housing affordability policy, most themes cut-across across a traditional divide in macroeconomic policy in being either (a) fiscal, (b) regulatory or (c) monetary (Glaeser and Gyourko, 2003). For fiscal subsidy, interventions in the housing market to enable housing affordability could include for example, public payments to housing suppliers and urban renewal programs involving housing (Rosen, 1985). Fiscal subsidies involving public spending, tax credit or cross subsidy from other tenants or landowners/developers appear to be in decline globally, especially as a proportion of the overall housing subsidy. Regulatory approaches in the strictest (rather than hybrid) sense are where interventions for housing affordability are enabled through enforceable quality standards, licencing, inclusionary/exclusionary zoning, non-discriminatory laws and rent controls. This command and control approach to housing affordability is further extended in planning frameworks (Austin et al., 2014) that can change land-use designations to instantaneously open and close supply for more housing (Beer et al., 2007).

A central consideration in macroeconomic debate around housing affordability is the use of monetary policy and in particular the purposeful adjustment of mortgage rates. Greater use of monetary repackaging of housing 'innovations' has enabled the upfront injection of money through bonds to subsidise housing unaffordability (Squires and Hutchison, 2014). Further monetary interventions in housing markets include stricter loan-to-value rates for lending, interest rate subsidies, and a forced increased flow of credit. Interest rate macroeconomic policy is therefore one of many policies, but in principle the perception is that changes to the interest base rate (and subsequent mortgage interest rate) will have an impact on whether investors (including home-owners) can afford to invest more in housing, as well as dampening or fuelling the housing market that has an eventual impact on house price affordability.

Whether consumers of and investors in housing stock are responsive to mortgage rate adjustments will depend on a complex array of contrasting financial and social stimuli. Stocks and shares traded on the financial markets are favoured by some as a potentially rewarding place to allocate savings. The knowledge that these savings can be used to stimulate further investment and expand the successes of particular companies can also be satisfying. Investments in the stock market can bring high rates of returns but will also periodically let the investor down due to their high rates of volatility. Greater uncertainty around the global financial markets, not least associated with the global financial crisis of 2007 onwards, and the association of crisis with driving forces of greed and the consequential increases in inequality, may have decreased the intrinsic desirability to place savings in this area. Allocating savings to support government initiatives in the form of purchasing treasury bonds tend to be a safer and nobler bet in the financial arena, but the rates of returns to these investments are traditionally lower albeit less volatile.

Investments in the housing stock, albeit with temporal concerns over house price crashes, are seen as a relative safe and financially rewarding bet over the longer term and can bring in flows of income over the shorter term through rental incomes (Jordà et al., 2017). Although higher mortgage rates can eat into the rates of return to investment by reducing the upward pressures on house prices, it does may not have the same dampening effect on the rental incomes. Higher mortgage rates may reduce the propensity of consumers to purchase a house to live in as their mortgage repayment payments will increase, but this indirectly leads those people into rental properties, and greater inflows of migrants into larger cities in particular in search of higher paying jobs puts greater upward pressure on rental values, which therefore may not diminish the incentive to purchase housing stock as an investment.

A second and potentially equally important factor in the decision to purchase a house is that ownership conveys differential level of kudos on the owner depending on quality, location, etc. Social desirability bias may drive home ownership, especially with the expansion of the middle class in many middle and high-income countries. Not on the housing ladder and being unable to own your own home can create a statement that an individual or household is not being successful and is dependent on the ruling class to provide shelter. Home ownership may therefore provide a signal to others that the household is not dependent on others and have a high level of financial security. The desire for greater social standing afforded by home ownership may make higher mortgage repayments worthwhile and tolerable. This line of argument would question whether the effectiveness of monetary policy through mortgage rate adjustments has reduced over time such that it is now less effective at traditional mortgage rate levels and instead needs to be set at much higher levels to reduce upward pressures on house prices that are demand driven.

The position and impact of interest and mortgage rates in New Zealand are often used to demonstrate why demand for purchasing property is high, and how interest rate setting can be a policy tool to dampen market demand (RBNZ, 2018). Literature in this field indicates that New Zealand has some interesting housing affordability differences and policy to those internationally (Lawson and Milligan, 2007). Compared to the United States, its housing composition for affordability is even more highly dependent on the owner-occupier market (Skidmore, 2014). Further, New Zealand as different has consistently seen a rising problem of affordability over the last 2 decades in one dominant region of major employment (Auckland) and one dominant region of tourist investment home interest (Central Otago Lakes, centred around the town of Queenstown) (REAU, 2018).

For New Zealand in terms of housing stock, a polar provision of both private and public stock has been traditionally provided (Johnson, 2017), with public housing intended more for those that cannot afford shelter at the lower end of the market by the Housing New Zealand Corporation (2018). A new labour-led coalition government in 2017 has made signals of a new attention to public provision starting from a baseline stocktake (Johnson et al., 2018). Housing affordability is further a concern that positions heavily in the political sphere in New Zealand (Murphy, 2014). With this public-private provision tension often played out over different ministries such as Public Housing Assistance in the Ministry for Social Development (MSD, 2017), and housing affordability a concern for the Ministry for Business, Innovation and Employment (MBIE, 2012). In alternative tenures, the private rental sector is becoming more prominent in New Zealand given the owner-occupiers market become out of reach for those without access to deposits (BRANZ, 2017). This rental sector for lower-socioeconomic groups and ethnicities has subsequently seen a rise in take up of Maori and Pacific groups, with Caucasians more able to participate in home ownership due to their more favourable labour market opportunities (Statistics New Zealand, 2016). As a result, arguments are now taking stage that for New Zealand a quasi-market approach is one to deal with the socioeconomic component of housing (Dykes, 2018).

Layered on this dominant market-led approach and affordability solutions, politically steered more towards market-based monetary solutions we see interest rates and banking interests of significance in policy discourse. Given the continued discussion of whether New Zealand has one very large house price bubble and one leading to the global financial crisis of 2007-08 (Fraser et al., 2008), its market was not taken in a steep decline in line with other countries. Arguably, property has not until 10 years later post-global financial crisis become dominant for the economy, and an (un)earned income for many in New Zealand. What is not apparent in the New Zealand related literature is how housing affordability can be met through its specific policy mechanisms such as those in planning (Austin et al., 2014). With a central problem for New Zealand monetary policy is its ability to control interest rates whilst its banks are dominated by Australian banks (Murphy, 2011). With this in mind, this paper demonstrates how the excessive market growth has been far too high for interest rates to have much effect on dampening housing markets in New Zealand – possibly viewing interest rates as more of a response to global monetary forces and other demand-related, such as conspicuous consumption, factors.

DATA

The empirical data used for this paper was drawn from the Real Estate Analysis Unit (Massey University, New Zealand) that has collated data over the last 2 decades for its quarterly Home Affordability Report (HAR). Their dataset contains quarterly observations for 12 regions between 2000 and 2017 inclusive in aggregate at two strictly hierarchical spatial scales: regional and national. Key data sets involve regional house prices, mortgage interest rates, and wage earnings. The average weekly earnings and mortgage interest rate figures are drawn from Statistics New Zealand and Reserve Bank data. Housing prices are sourced from the Real Estate Institute of New Zealand (REINZ). The 3 sets of data are also combined to generate an affordability index value. The index value is calculated by multiplying house prices by the mortgage interest rate on the numerator, then dividing through on the denominator by the average wage. The combination of this data provides the opportunity to calculate a reliable and useful summary index, where the lower the index value the more affordable the housing. The index allows for comparisons over time and between regions of relative housing affordability in New Zealand. We note the terminology of index being used here as not

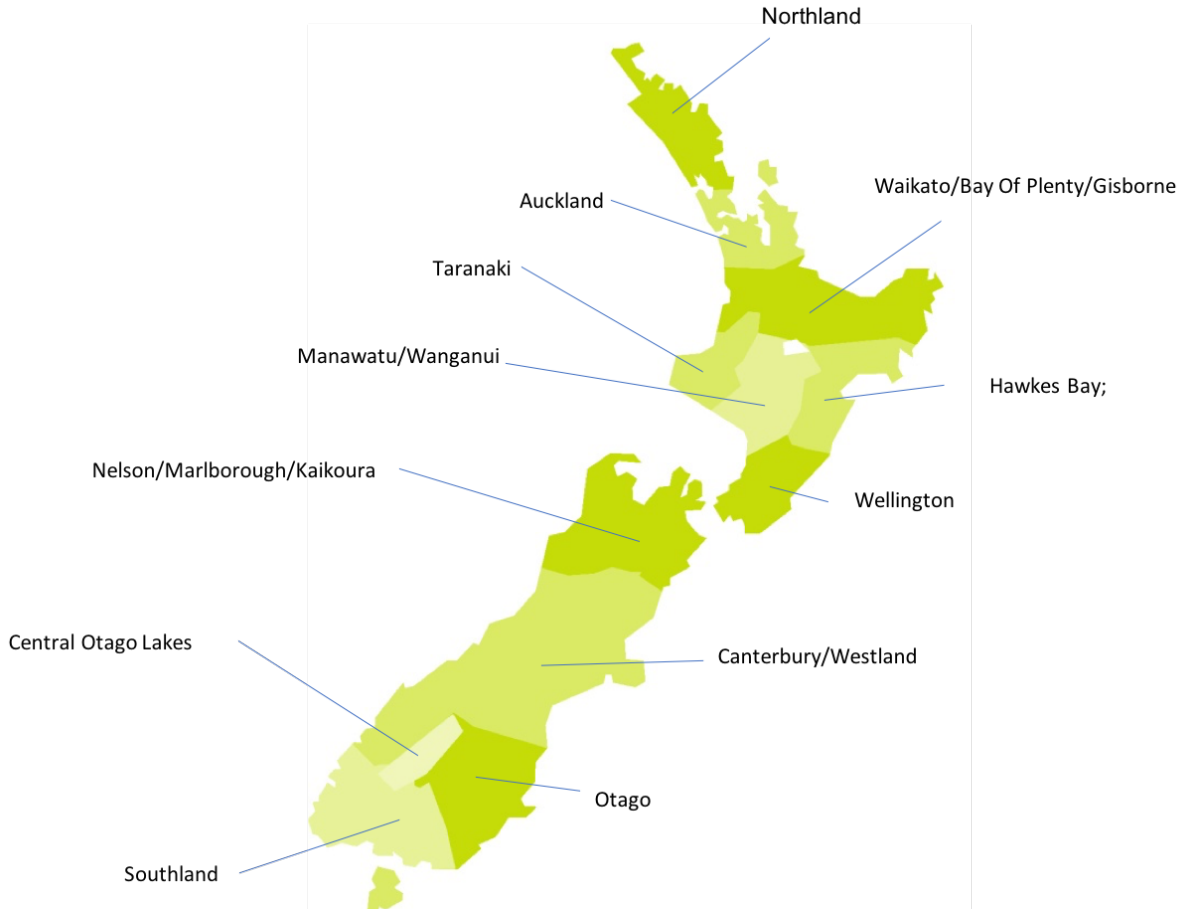
in the traditional economic sense, such as being an index number that is relative to the magnitude at a specified point such as 100.

To provide more depth on the data, median dwelling prices for various regions within New Zealand are released monthly by the REINZ. The figures are obtained from a survey of member agencies' sales during that specific month. It is noted by the agency that there may be irregularities in the data resulting from errors in the returns or processing, but when individual returns are combined with those of other agencies the distortion is likely to be small. In some months there may be very few transactions and this can result in somewhat skewed median prices. Average national and regional weekly earnings data is provided directly by Statistics New Zealand. The interest rate data is based on Reserve Bank New Zealand (RBNZ) 2-year fixed new residential average mortgage interest rates at the end of month for registered banks.

Data on house prices and wages are aggregated at a regional scale, thus it is worth noting here the statistical geographical units that relate to the regions. There is point data for specific location sales on a plot or parcel. In collecting this point data, a meshblock is the smallest geographic unit for which statistical data is collected by Statistics NZ. Meshblocks usually contain a population of approximately 200 – 300, though this can vary due to industrial/commercial areas, population changes and other factors. Meshblocks aggregate to build larger geographic areas, such as area units, territorial authorities, and regional councils. The total number of meshblocks nationally usually increases with each census, due to population changes. As of the 2013 census, there are 46,637 meshblocks in New Zealand (CoreLogic, 2018). Census area units are an aggregation of meshblocks, similar in size to a suburb, however they do not align to suburb boundaries. In urban areas the population of an area unit is approximately 3000 – 5000. There are over 2000 area units in New Zealand. Territorial authorities are the second tier of local government in New Zealand, below regional councils. There are 67 territorial authorities: 12 city councils, 53 district councils, Auckland Council and Chatham Islands Council. Note that Auckland data has previously used council boundaries, as opposed to the now Auckland Super City boundary. Administration layer includes local and central government administrative zoning such as Territorial Authority boundaries, Regional Councils, Electoral boundaries and Statistics New Zealand boundaries such as meshblocks. Other data included are the NZ Fire Service localities (most commonly used suburb definitions), postcodes and school zones (CoreLogic, 2018).

For this study, regional statistics (as different to regional council administrative boundaries) in New Zealand are collated in 12 bounded geographies that include Northland; Auckland; Waikato/Bay Of Plenty/Gisborne; Hawkes Bay; Taranaki; Manawatu/Wanganui (Combined); Wellington; Nelson/Marlborough/Kaikoura (Combined); Canterbury/Westland (Combined); Otago; Central Otago Lakes; and Southland. We can see in figure 1 that these 12 regions are placed over both the North and South islands of New Zealand.

Figure 1: Map of regional boundaries in New Zealand for statistical data collection



Source: Real Estate Analysis Unit (Massey University, New Zealand)

METHODOLOGY

We require a methodology that identifies whether there are groups of regions whose house price trajectories follow similar paths of time, and therefore to identify the presence, magnitudes and significance of interregional evolutionary disparities in house prices across all regions of New Zealand. We also require that methodology to reveal the importance of the mortgage rate adjustments of various lag lengths and the global financial crisis on the trajectories of those regional clusters. Although this is not a trivial undertaking, a method that permits the identification of these patterns is Nagin's (2005) trajectory analysis.

Our second analytical task is to identify whether there are groups of regions that follow similar affordability growth paths. Nagin's (2005) group-based trajectory approach is implemented here to identify if distinctive groups of regions follow similar affordability trajectories, to explore these affordability trajectories themselves and, most importantly for this article, to ascertain whether there are groups of regions that experience similar affordability outcomes.

Nagin's (2005) trajectory modelling approach permits the identification of groups of regions with distinctive affordability trajectories that are not defined a priori but instead are conceived as latent and to be identified. This inductive approach allows for the identification of patterns and trends, and as group membership is conceived probabilistically and not as a deterministic outcome then the results show the probability that each region belongs to an identified group.

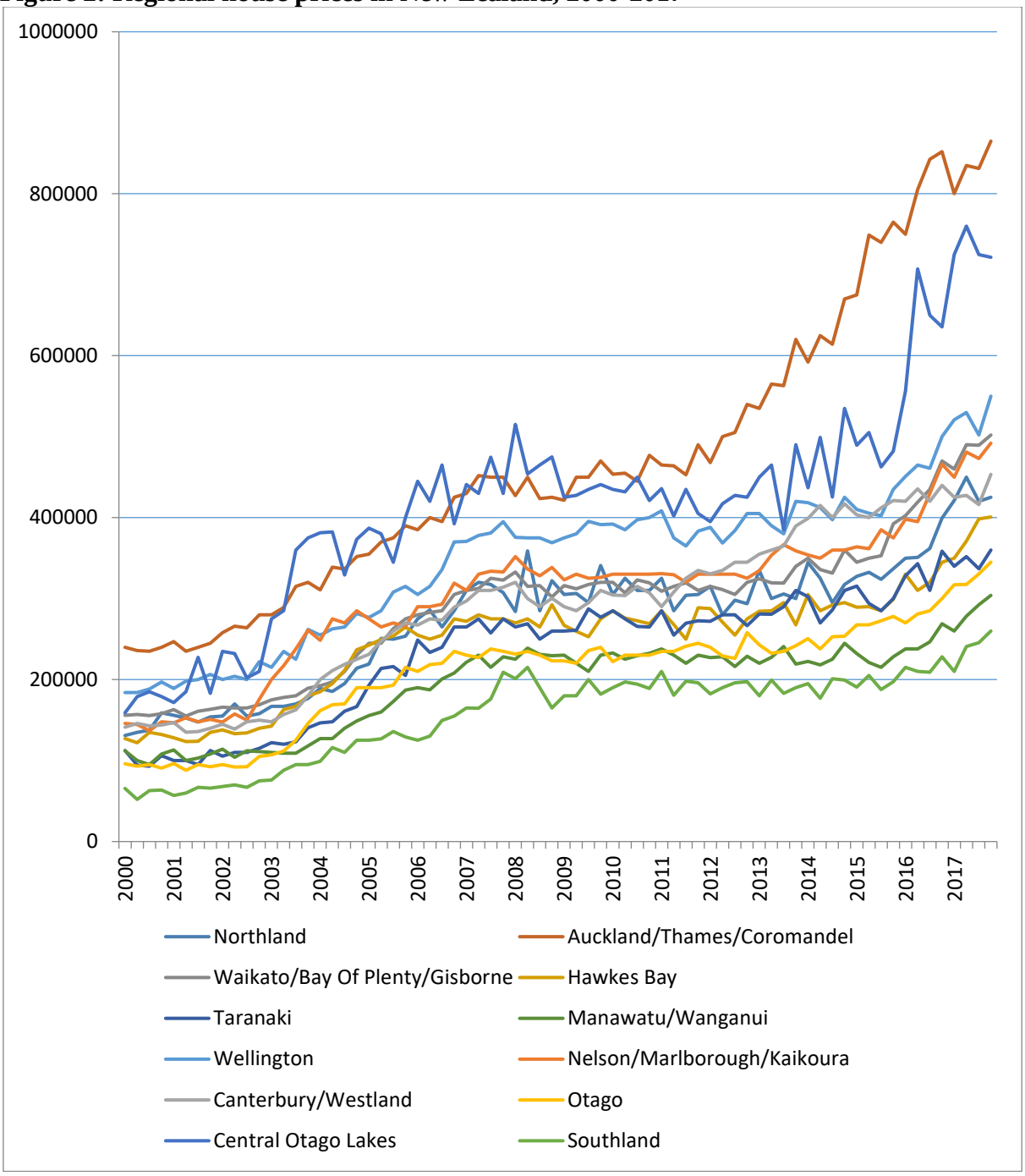
FINDINGS AND DISCUSSION

Our first analytical task is to provide descriptive trends by visualizing the changes in house prices for each of the regions over the sample time period, 2000-2017. Trends in wages are visualized by showing the longitudinal trends in annual wage rates for each of the 12 regions in question. Finally, descriptive baseline trends in interest rates are also visualized by charting the changing interest rate over the period 2000-2017 as applied to all regions at a national scale for New Zealand.

Regional house prices for New Zealand demonstrate the significant regional skew by Auckland and Central Otago Lakes (Figure 2). We see Auckland's steady incline from median prices of $240,000 NZD in 2000 to $430,000 NZD in 2010, followed by the post-global financial crisis plateau prior to a steeper incline to $870,000 by 2017 during which there was effectively a doubling of house prices over a 7-year period for the highly dominant Auckland region. The Central Otago Lakes, which contains Queenstown, saw significant house price changes with post-global financial crisis at approximately $400,000 NZD rising to 750,000 on 2017, but this region's housing market is more volatile due to a lower quantity of housing stock compared to the Auckland region and because demand is driven, at least in part, by a sizeable demand for second homes. Most other regional housing market prices have risen at a relatively uniform rate with a few exceptions, such as Waikato whose juxtaposition to the Auckland region has enabled it to take some of the heat from Auckland.

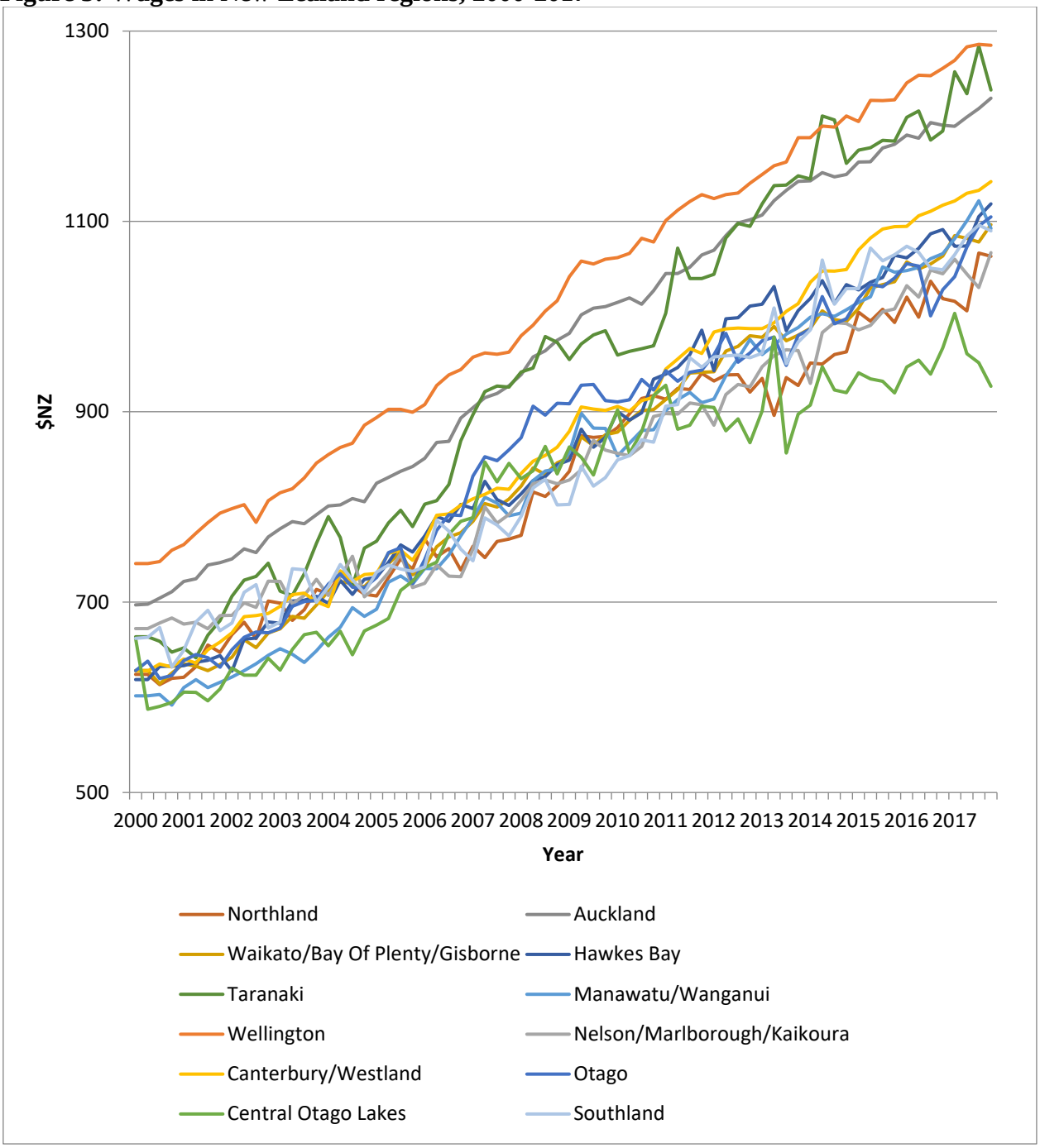
When we look at wage rates for New Zealand regions it is interesting to see the region of Central Otago Lakes having the lowest wage compared to the rest of New Zealand's regions, especially when set against its known high house prices (Figure 3). Average weekly earnings in Central Otago Lakes have risen from approximately $600 NZD in 2000 to approximately $900 NZD in 2017. Central Otago Lakes also demonstrate some wage volatility, arguably due to its seasonal labour force as a tourist destination. Of similar interest is the average wage climb in the Taranaki region. Taranaki has seen an increase from $650 NZD in 2000 to become the second highest average regional wage at $1400 NZD, and this region's port/oil industry may have an important influence here. It is also pertinent to see that Wellington has the highest wages, despite many general core industries being located in Auckland. The high and uniform climb of wages in Wellington to almost $1300 NZD can be emblematic of a more stable workforce in the public service, academic and professional services sectors in Wellington, whereas Auckland and Central Otago Lakes have higher proportions of more casual employment, despite both region's experiencing steep house price acceleration.

Figure 2: Regional house prices in New Zealand, 2000-2017



Source: Authors' calculations using REINZ Data

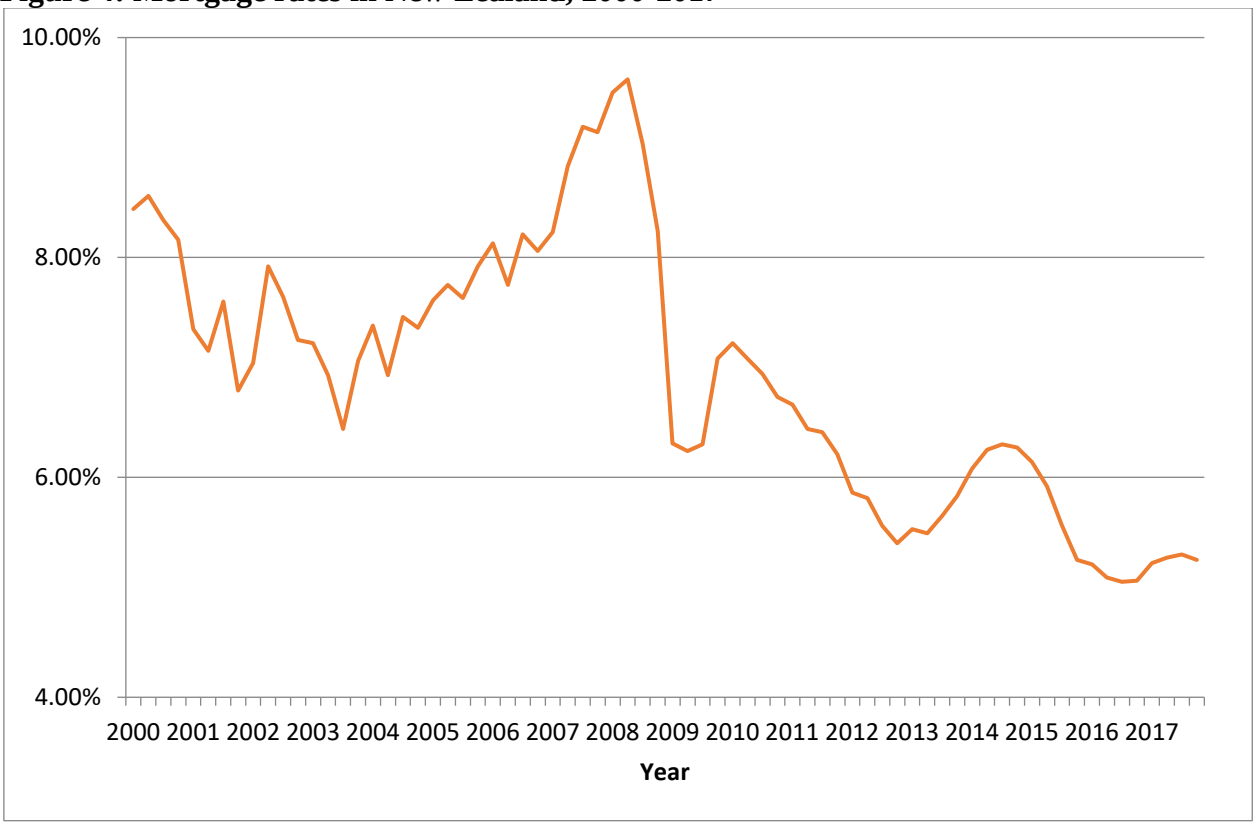
Figure 3: Wages in New Zealand regions, 2000-2017



Source: Authors's calculations using Statistics New Zealand Data

Over the entire period of consideration, there has been a downward trend in mortgage rates across New Zealand (Figure 4). Within this downward trend we see the mortgage rate rise from mid 2003 to 2008 when the effects of the global financial crisis took the rate steeply downwards from approximately 9.5% to 6.5%. The post global financial crisis fall was then followed by a steady cyclical decline containing two peaks of approximately 7% in 2010 and 6% mid 2014-15. Continual low interest rates have been argued as one factor affecting housing affordability given that the cost of borrowing has been low. Contrary to this access factor are a multitude of home affordability barriers such as loan-to-value ratios, increasingly high deposit funds, and high house prices to wage ratios.

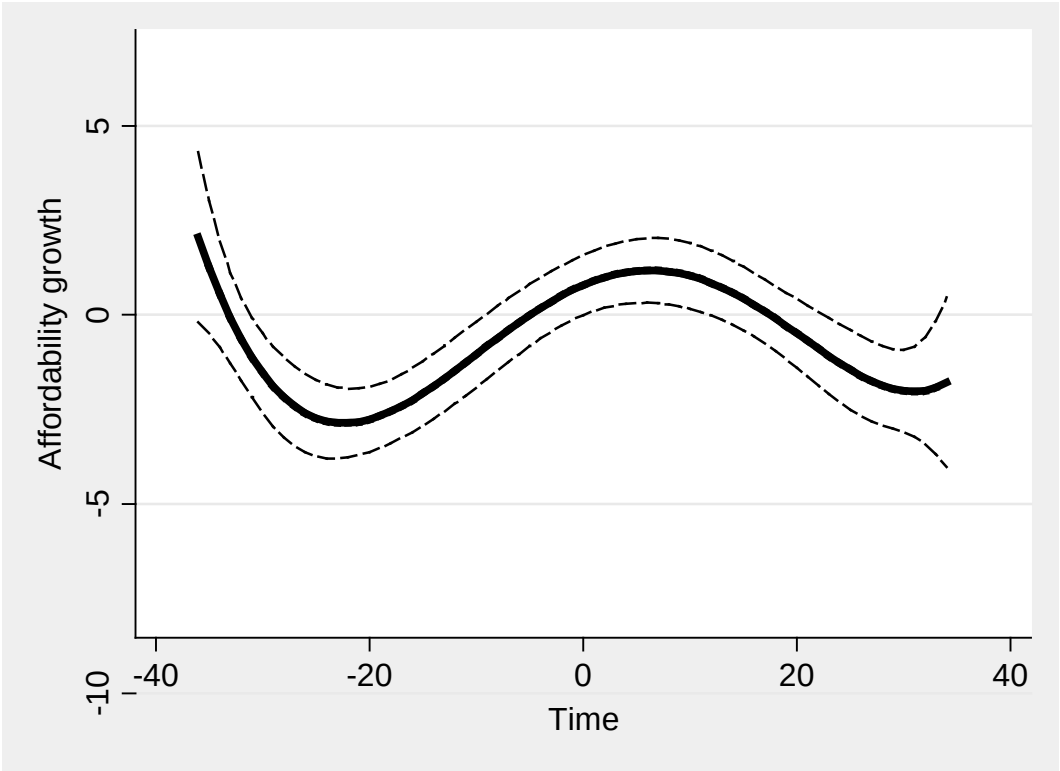
Figure 4: Mortgage rates in New Zealand, 2000-2017



Source: Authors' calculations

Our final stage of data description concerns the change in the affordability of house prices, as shown in figure 5. This figure illustrates that average regional year-on-year affordability fell sharply in the early 2000s, which is a particularly bad time to be a purchaser of houses, this slowed after around 2003 but continued to fall until the global financial crisis when affordability began to increase. This improvement in average regional affordability continued until 2011 after which it began to decline again. Figure 5 therefore illustrates the mechanics of how a market increases its rate of change as we approach the global financial crisis until it plateaus and then starts to decline its rate of change following the global financial crisis. To delve more deeply into the differential trajectories we now turn our main findings to the swings in housing affordability that are being experienced to different extents across New Zealand's regions.

Figure 5: Housing affordability growth



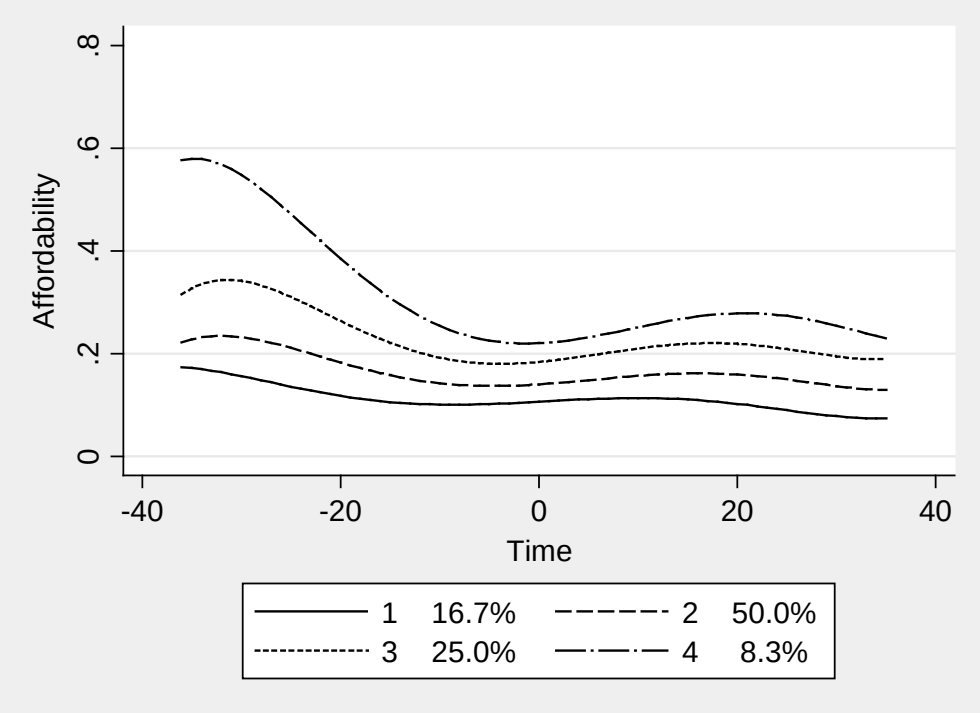
Source: Authors' calculations using Massey University's Home Affordability Index

Trajectory regressions

To identify similar trajectories of regional house prices we apply trajectory regressions to identify regions that follow similar trajectory paths. These groups can now be used to (a) analyse the asymmetric effect of mortgage interest rate lags, and (b) whether the global financial crises affected house price affordability differentially amongst the different regional groups.

The trajectory analysis revealed 4 groups of regions that have followed distinctly different trajectories with respect to the house price affordability index, as shown in Figure 6 and with group membership and explanations provided in Table 1. Group 1 contains the regions of 'Auckland' and 'Central Otago Lakes', as argued above to have experienced significant house price rises and are the least affordable regions in New Zealand. Group 2 contains the bulk of the New Zealand regions, and this cluster of regions are arguably grouped on account of their significant but secondary housing markets and are regions within commutable distance to core labour markets. The third group of regions are located at a significant distance from main labour markets, making it impractical for many to commute to core markets, and have collectively lower house prices. The fourth group contains just one region, Southland, which stands out as a unique region at the extreme southern point of New Zealand's South Island making it isolated geographically and consistently at the lower end of house prices.

Figure 6: New Zealand housing affordability rate of change trajectory groups



Source: Authors' calculations using Massey University's Home Affordability Index

Table 1: Trajectory groups and explanations

	Region(s)	Grouping explanation
Group 1	Auckland/Thames/Coromandel Central Otago Lakes	High unaffordability
Group 2	Canterbury/Westland Hawkes Bay Nelson/Marlborough/Ka Northland Waikato/Bay Of Plenty Wellington	Significant secondary housing markets with proximity to core labour markets
Group 3	Manawatu/Wanganui Otago Taranaki	Often more affordable housing markets with less proximity to core labour markets
Group 4	Southland	Isolated geographically and consistently at the lower end of housing market prices

Source: Authors calculations using Massey University's Home Affordability Index

Figure 6 reveals that the cycles of housing affordability are experienced to different extents across the country with Auckland's trajectory group (Group 1) experiencing, in relative terms, an almost monotonic and shallow downwards trajectory. Affordability in house prices in Group 1 (Auckland, etc.) has always been the lowest and has annual wages now less than 10% of the average house price. Group 1's heavy disproportionality means that sensitivity starts to diminish.

Conversely, the disproportionality of wages and house prices show that Group 4 (Southland) with low house prices is more sensitive to affordability. Southland (Group 4) experienced the sharpest fall in affordability between time -32 (8 years – 32 quarters – before the global financial crisis) and time zero (the end of 2007 and the start of the global financial crisis). Group 4 (Southland) used to be relatively affordable, with annual wages (Figure 2) being over 50% of the average house price in 2000 (Figure 1). The affordability

of homes in Southland fell substantially but annual wages still remain greater than 20% of the average house price (Figures 1 and 2). House prices in this area converged with the other groups in the early 2000s (Figure 1), probably because house prices in Southland rose at a faster percentage rate than the other groups.

The immediate post-global financial crisis period reveals some commonality across the four groupings with greater similarity in the slopes of the trajectory lines and even a slight improvement in affordability because during this period wages were growing faster than house prices (Figure 2). Improvements in affordability seem to come to an end at a later stage when the group has relatively greater affordability; for instance, affordability begins to drop first in the most unaffordable region (group 1) and last in the least affordable region (group 4). After their respective turning points on figure 4, affordability then continues to decline across all regions up to the end of the period under scrutiny.

How sensitive were these groups' trajectories to the global financial crisis?

We now turn to investigate whether the global financial crisis affected house price affordability differentially in different regions, and these results are presented in table 2. In this case we are using a dummy variable to represent the time period after the start of the global financial crisis until the end of the time period under examination; the reason for instrumentalising the effect of the global financial crisis as a intercept change is that we do not know if and when the effect of the global financial crisis on house price affordability came to an end and whether this end occurred differentially across groups of regions, but when a longer time period of data is available post global financial crisis then this effect could be explored in more depth.

Table 2: Global financial crisis regression results

	Trajectory group					
	1	**2**	**3**	**4**	**BIC**	**AIC**
Global financial crisis	0.001 (0.009)	0.011** (0.005)	0.029*** (0.007)	-0.016 (0.012)	2188	2264

Source: Authors' estimations

Table 3 illustrates that the global financial crisis can be thought of as a structural change but the effect can be identified statistically for only two groups of regions using this dynamic model. Groups 1 and 4 appear not to have been statistically significantly affected by this shock whereas groups 2 and 3 were affected significantly by this shock. This asymmetric statistical effect seems to suggest that the cycle of housing affordability remained the same in the 'high unaffordability' and 'isolated' groups of regions (Groups 1 and 4). Whereas the regions with 'secondary housing market and labour market access' and 'more affordable and less proximity to core labour markets' (Groups 2 and 3) experienced the greatest improvement in affordability. We can postulate on this improvement in affordability perhaps because demand dropped and thus reduced the upward pressure on house prices.

How sensitive were these groups' trajectories to mortgage rate changes?

Given these four trajectory groupings we can proceed to analyse the affect of mortgage rate changes on house price affordability. Table 3 presents the temporal covariance regression estimates of the effect of mortgage rates with various temporal lags on affordability. All coefficients are insignificantly different from zero, suggesting that over this time period changes in the mortgage rate had no significant impact on the housing affordability trajectories of all regional groups. This runs intuitively to the

acknowledgement that affordability over 2000-17 has been more a function of house prices rather than wages or interest rates.

Table 3: Mortgage rate regression results

	Trajectory group					
	1	**2**	**3**	**4**	**BIC**	**AIC**
Mortgage rate						
0 quarter lag	-0.000 (0.003)	-0.002 (0.001)	0.002 (0.002)	-0.001 (0.004)	2177	2253
1 quarter lag	0.001 (0.003)	-0.001 (0.002)	0.002 (0.002)	-0.002 (0.004)	2160	2236
2 quarters lag	0.000 (0.003)	-0.001 (0.001)	0.002 (0.002)	-0.000 (0.004)	2142	2218
3 quarters lag	0.000 (0.003)	-0.001 (0.001)	0.002 (0.002)	-0.001 (0.004)	2113	2189
4 quarters lag	0.000 (0.003)	-0.001 (0.001)	0.002 (0.002)	-0.001 (0.004)	2098	2173

Source: Authors' estimations

CONCLUSION

To conclude, first we visualise the intrinsic connectivity and considerable change of house prices, wages and interest rates when exploring house price affordability between 2000 and 2017. For New Zealand and its regions as case, house prices have clearly led on an upward trajectory, with exponential increases since the GFC in the dominant labour and housing market of Auckland region, and the more seasonal tourist labour and investment home market in Central Otago Lakes region (including Queenstown). Wages take a similar upward trend although at a disproportional rate to house prices, with interestingly high wages in the regions of Wellington (the public and services capital), and the region of Taranaki (with a significant oil and gas port). Wage differentials in Auckland are also high, particularly in relation to the Central Otago Lakes region that has the lowest wages average for a region in New Zealand from 2013-2017. Regional variances in house prices and wages are marked against a national interest rate that has seen a decline from the GFC in 2007-08 to 2017.

Second, we then assessed whether these house price and wage variables, as an affordability index, showed signs of upwards or downward growth change in the affordability of house prices. At a national aggregate (of regions) scale we demonstrate that affordability post GFC begins to decline in its rate of change as a lagged effect.

Third, to undercover this lagged effect we thirdly determined 4 core housing affordability groups that clustered in similar regional trajectories found in affordability over the time series. The most prominent trajectory group rate of change was for the more isolated group 4 (Southland), in economic-geography and by group selection as the only region in the grouping. That demonstrated for this isolated group, a significantly different (relative to the other 3 groups) rate of change decline leading up to the GFC. We also observe further but less protracted asymmetries in the housing affordability rate of change for the trajectory groups post GFC.

Fourth, this asymmetry is also demonstrated when demonstrating how sensitive the trajectory groups were to the GFC at a regional scale of analysis. Results showed that the GFC in addition to being seen as all-encompassing structural change can also be seen as a having statistical shocks that had different regional asymmetric effects. For the New Zealand trajectory groups, the shock in the 2 regions exemplified as having 'high

unaffordability' and 'isolated' did not have much effect on their affordability cycle. Whereas the other 2 regional groups exemplified by 'secondary housing market and labour market access' and 'more affordable and less proximity to core labour markets' were affected significantly by the GFC shock.

Fifth and finally, when revealing lagged sensitivity effects of mortgage rates for different regional house price trajectories we postulate that mortgage rates have a degree of (ir)relevance. Mainly that there is no impact when applying temporal covariance regression estimates of the effect of mortgage rates with various temporal lags on affordability. These findings therefore provide a basis to question and stimulate further research as to whether some policy responses to affordability are relevant, for instance whether monetary policies on interest rates have the impact on dampening house prices. Particularly when interest rate changes could be more of a response to other global and regional monetary forces such as the conspicuous consumption that housing wealth affords.

REFERENCES

Austin, P. M., Gurran, N., & Whitehead, C. M. (2014). Planning and affordable housing in Australia, New Zealand and England: common culture; different mechanisms. Journal of Housing and the Built Environment, 29(3), 455-472.

Beer, A., Kearins, B., & Pieters, H. (2007). Housing affordability and planning in Australia: the challenge of policy under neo-liberalism. *Housing Studies*, 22(1), 11-24.

Bourassa, S. C., Hoesli, M., & Sun, J. (2006). A simple alternative house price index method. Journal of Housing Economics, 15(1), 80-97.

BRANZ. (2017) The New Zealand Rental Sector Report ER22. Wellington: BRANZ

Bryman, A. (2015). *Social research methods*. Oxford University Press.

Cerutti, E., Dagher, J., & Dell'Ariccia, G. (2017). Housing finance and real-estate booms: a cross-country perspective. *Journal of Housing Economics*, *38*, 1-13.

Chen, J., Hao, Q., & Stephens, M. (2010). Assessing housing affordability in post-reform China: a case study of Shanghai. Housing Studies, 25(6), 877-901.

Claessens, S., Dell'Ariccia, G., Igan, D., & Laeven, L. (2010). Cross-country experiences and policy implications from the global financial crisis. Economic Policy, 25(62), 267-293.

CoreLogic (2018). http://www.corelogic.co.nz/

Crotty, J. (2009). Structural causes of the global financial crisis: a critical assessment of the 'new financial architecture'. Cambridge journal of economics, 33(4), 563-580.

Damen, S., Vastmans, F., & Buyst, E. (2016). The effect of mortgage interest deduction and mortgage characteristics on house prices. *Journal of Housing Economics*, *34*, 15-29.

Demographia (2018) 14th Annual Demographia International Demographia International Housing Affordability Survey: 2018 Rating Middle-Income Housing Affordability. http://www.demographia.com/dhi.pdf [Accessed 7th March 2018]

Dykes, P. (2018). The quasi-market approach: the answer for social housing in New Zealand?. Policy Quarterly, 12(2).

Fraser, P., Hoesli, M., & McAlevey, L. (2008). House prices and bubbles in New Zealand. The Journal of Real Estate Finance and Economics, 37(1), 71-91.

Gabriel, S. A., Shack-Marquez, J., & Wascher, W. L. (1992). Regional house-price dispersion and interregional migration. Journal of Housing Economics, 2(3), 235-256.

Gan, Q., & Hill, R. J. (2009). Measuring housing affordability: Looking beyond the median. Journal of Housing economics, 18(2), 115-125.

Gibb, K., & Whitehead, C. (2007). Towards the more effective use of housing finance and subsidy. *Housing Studies*, 22(2), 183-200

Glaeser, E., Gyourko, J. (2003) The impact of building restrictions on housing affordability. *Economic Policy Review*, 9(2), 21–39.

Harvey, D. (2012). *Rebel cities: From the right to the city to the urban revolution*. Verso Books.

Housing New Zealand Corporation. (2017). Annual report 2016/2017. Housing New Zealand Corporation

Hubbard, R. G., & Mayer, C. J. (2009). The mortgage market meltdown and house prices. *The BE Journal of Economic Analysis & Policy*, *9*(3).

Iacoviello, M. (2005). House prices, borrowing constraints, and monetary policy in the business cycle. *American economic review*, *95*(3), 739-764.

Johnson, A. (2017) Taking Stock: The Demand for Social Housing in New Zealand.

Johnson, A., Howden-Chapman, P., Eaqub, S. (2018). A Stocktake of New Zealand's Housing. Crown Copyright. https://www.beehive.govt.nz/sites/default/files/2018-02/A%20Stocktake%20Of%20New%20Zealand%27s%20Housing.pdf

Johnson, A., Howden-Chapman, P., Eaqub, S. (2018). A Stocktake of New Zealand's Housing. Crown Copyright. https://www.beehive.govt.nz/sites/default/files/2018-02/A%20Stocktake%20Of%20New%20Zealand%27s%20Housing.pdf [accessed 22nd February 2018]

Jordà, Ò., Knoll, K., Kuvshinov, D., Schularick, M. and Taylor, A. M. (2017) 'The rate of return on everything, 1870-2015', NBER working paper 24112.

Kim, K. H., & Renaud, B. (2009). The global house price boom and its unwinding: an analysis and a commentary. *Housing Studies*, *24*(1), 7-24.

Kuang, W., & Li, X. (2012). Does China face a housing affordability issue? Evidence from 35 cities in China. *International Journal of Housing Markets and Analysis*, 5(3), 272-288.

Lawson, J., & Milligan, V. (2007). International trends in housing and policy responses. AHURi. http://www.iut.nu/Literature/2007/InternTrendsHousingPolicyResponses_LawsonMilligan2007.pdf [accessed 22nd February 2018]

Martin, R. (2011). The local geographies of the financial crisis: from the housing bubble to economic recession and beyond. *Journal of Economic Geography*, *11*(4), 587-618.

Massey University (2018) Real Estate Analysis Unit. Massey University, New Zealand

Matlack, J. L., & Vigdor, J. L. (2008). Do rising tides lift all prices? Income inequality and housing affordability. *Journal of Housing Economics*, *17*(3), 212-224.

MBIE - Ministry for Business, Innovation and Employment. (2012). Housing Affordability Inquiry. Wellington: New Zealand Productivity Commission. MBIE

Meen, G and Andrew, M. (2008); Planning for housing in the post-Barker era: affordability, household formation, and tenure choice, *Oxford Review of Economic Policy*, 24(1), 79–98

MSD - Ministry of Social Development (2017) Social Housing Update – December 2017

Murphy, L. (2011). The global financial crisis and the Australian and New Zealand housing markets. Journal of Housing and the Built Environment, 26(3), 335.

Murphy, L. (2014). 'Houston, we've got a problem': The Political Construction of a Housing Affordability Metric in New Zealand. *Housing Studies*, 29 (7), 893-909.

Murphy, L. (2016). The politics of land supply and affordable housing: Auckland's Housing Accord and Special Housing Areas. Urban Studies, 53(12), 2530-2547.

Nagin, D. S. (2005) *Group-based modelling of development.* Harvard University Press

RBNZ - Reserve Bank New Zealand. (2018). https://www.rbnz.govt.nz/

REAU - University Real Estate Analysis Unit (2018). Home Affordability Reports. Massey University available at http://www.massey.ac.nz/massey/learning/colleges/collegebusiness/school-of-economics-and-finance/research/mureau/mureau_home.cfm

REINZ – Real Estate Institute New Zealand. (2018). https://www.reinz.co.nz/residential-property-data-gallery

Rosen, H. S. (1985). Housing subsidies: Effects on housing decisions, efficiency, and equity. *Handbook of Public Economics*, 1, 375-420.

Skidmore, M. (2014) Housing Affordability: Lessons from the United States. Working Paper 07/2014 Working Papers in Public Finance. Victoria University Wellington. https://www.victoria.ac.nz/sacl/centres-and-institutes/cpf/publications/pdfs/2015/WP07_2014_Housing-Affordability.pdf

Squires, G. and Hutchison, N. (2014) 'The life and death of Tax Increment Financing (TIF) for redevelopment: Lessons in affordable housing and implementation' *Property Management*, 32(5), 368-377

Statistics New Zealand (2016) Changes in home-ownership patterns 1986–2013: Focus on Māori and Pacific people. Wellington: Statistics New Zealand.

Stone, M. E. (2006) What is housing affordability? The case for the residual income approach. *Housing policy debate*, *17*(1), 151-184

Voith, R.P. and Wachter, S. M. (2009) Urban growth and housing affordability: The conflict. *The Annals of the American academy of political and social science*, 626(1), 112-131

Yin, R.K. (2009) *Case study research: Design and Methods*. SAGE publications. Thousand oaks

Zhu, B., Betzinger, M., & Sebastian, S. (2017). Housing market stability, mortgage market structure, and monetary policy: Evidence from the euro area. *Journal of Housing Economics*, *37*, 1-21.

”I WON’T MOVE TO A ONE BEDROOM DOG BOX”: THE CHALLENGES OF DOWNSIZING FOR OLDER SOCIAL HOUSING TENANTS IN QUEENSLAND, AUSTRALIA

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Abstract
Older tenants living in detached dwellings occupy much of Australia’s social housing landscape. As these tenants age, many find themselves living alone in two, three or more-bedroom homes, which authorities perceive as under-occupied. In this research of over 150 older social housing tenants in Logan, Queensland, the surprising finding was that most of the older tenants interviewed wanted to stay in their homes, despite the number of bedrooms and the size of the yard. Each of the spare bedrooms had a purpose, and the sentimental attachment to the family home was strong. This represents a serious dilemma for social housing agencies who face pressure from long waiting lists and limited housing stock. The identification of a number of ‘potential movers’ among the sample group, assisted the researchers to investigate the key factors that would motivate this group of older social housing tenants to move to a smaller home. If these factors can be satisfied in new housing, then older social housing tenants may be prepared to move to smaller homes. Understanding and delivering the factors that motivate a move is important for both older social housing tenants and social housing providers.

Keywords: Downsizing; Social Housing; Aging in Place, Housing Affordability

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OLDER PEOPLE IN SOCIAL HOUSING

At the heart of downsizing is the capacity of individuals or households to make the move to a suitable smaller home. Older social housing tenants may not feel that they have a say in the decision to downsize as they do not own the home and they feel some pressure to move out of larger housing stock to make way for families. This paper explores the motivations, housing and neighbourhood aspirations and needs of older social housing tenants who want to stay in their homes and those who will consider moving (downsizing) to smaller social housing accommodation. This is important research as many older social housing tenants occupy family homes and there is some pressure on this group to relocate to smaller properties to free up the larger homes. The site of the research is Logan City, Queensland, Australia where 151 older social housing tenants participated in the investigation. Many of those interviewed felt the pressure to move and most were resistant to moving.

Place-based needs and aspirations

The concept of home and the meaning of place has been extensively discussed in academic literature for over thirty years, formulating a multi-dimensional, multi-layered understanding of the topic (Moore 2000). Place can be described as space that has meaning formulating a unique entity for an individual. Home is described as an extension of self through places. The concepts of home and place are often integrated with one another. The meaning of home and place is important for older residents as an attachment to place becomes stronger as people age (Wiles et.al 2009). This is particularly important for older residents as they often draw meaning and security from the place in which they live (Wiles et.al 2009). Whilst it is recognised that there is a relationship between place and aging there is currently a limited understanding as to the extent of this relationship and its impact on healthy aging in place (Cutchin 2005).

However, the importance of home and place to older people is indisputable as studies such as those undertaken by Wiles et.al (2011), Wiles et.al (2009) and Peace, Holland and Kellahers (2006) identify that attachment to home and place can significantly enhance quality of life. This understanding of the importance of home and place is a key finding in the current research. Attachment to the neighbourhood and specific features such as proximity to a familiar doctor, shops and family members was significant for the older social housing tenants surveyed for this research, no matter whether they considering transitioning to a smaller home or not. These findings are supported by Olsberg and Winters (2005) who identified through a national survey of older Australian residents that 64.4% wanted to stay in their home and age in place.

Downsizing: Barriers preventing older tenants from transitioning

Stimson and McCrae (2004) describe the reasons for older Australians moving as a result of push and pull factors including the push factors of change of lifestyle, maintenance, social isolation and declining mobility. Pull factors include the built environment and affordability, location, and maintenance of existing lifestyle and familiarity.

Common reasons for downsizing amongst older Australians include:

- Lifestyle preference;
- Inability to maintain the house or garden;
- Illness and disability;
- Retirement of self or partner;
- The need for a more accessible dwelling;
- To obtain a higher level of care services; and
- To be closer to family (Judd et.al 2014).

The single greatest factor that determines if older people will move is closely related to involuntary push factors such as accessibility of the home and declining health and mobility.

METHODOLOGY

The research was designed to understand the aspirations of social housing tenants over the age of 55 in the Logan City Council area who are living in detached homes with two or more 'spare' bedrooms in those homes. The research investigated housing and neighbourhood satisfaction, as well as the services or assistance required to remain living independently and the factors that might motivate downsizing to another, smaller home. The Department of Housing and Public Works (DHPW) contacted 560 eligible tenants as potential participants for face-to-face interviews or telephone interviews (tenant's choice) to be handled by the University of Queensland (UQ) research team. A total of 151 social housing tenants participated in the research.

One limitation observed in this process was that due to the unexpected popularity of the research, most people contacted agreed to be interviewed. While this is a good outcome, the tenant list for the recruitment was not randomised, but ordered by length of tenancy. Thereby, the sample of 151 is skewed to longer term social housing tenants as they were the first contacted when recruiting research participants. Reasons for the popularity of the research for tenant participants was the strong desire to have a say in their housing future and their perceived uncertainty with their current housing arrangements, given they are under-occupying their homes by 2 or more bedrooms and acutely aware of this situation. This quote from a tenant illustrates the point "I was terrified of being forced out when the Housing Minister announced a few years ago that tenants would be moved out if the home was 'not suitable for their needs'" (Brisbane Housing Company, 2017, p.19). Tenure was identified 17 times in the open-ended responses (11%), with respondents expressing concerns about security of tenure and being forced out of their home (Brisbane Housing Company, 2017, p.19).

Approximately 19% of the respondents were in the 75 and over cohort, while more than half of the participants reported some form of disability. Over half of the respondents (51%) also reported having fair to poor health. Therefore, a significant percentage of the tenants that were interviewed were faced with physical uncertainty.

While the sample size of 25% of all eligible Logan tenants was significant, the primary focus of the research was understanding the aspirations of the 55 respondents who were identified as potential transitioners. These individuals considered alternative housing options, and as such are of interest to policy makers when developing housing solutions that could facilitate the relocation of older housing tenants.

The interviews were conducted in the homes of the participants, as well as in the Woodridge Housing Service Centre, and via phone calls. The interview data was combined with the DHPW tenant datasets to identify: suburb; household type; disability; the age of the oldest tenant; age of the home; length of tenure; bedroom and living area size in the home and lot size. This produced rich typological, locational and needs based data. In this paper, that information is reported for the total sample, and those who indicated an interest in relocation (potential transitioners) (Judd et al, 2014).

Potential Transitioners

About 1/3 of the surveyed tenants (55/151) expressed a willingness to relocate from their current home. That is, 55 tenants are potential transitioners. Most of the potential transitioners were single females aged between 65 and 74. Their main concerns were safety in the community as well as their own health and ability to manage in the home for

the next ten years. There were more reports of disability and difficulty moving around from the potential transitioners than from the overall sample. As explained in the literature, there is evidence to suggest that vulnerable groups facing mobility challenges in the home and neighbourhood are more inclined to consider downsizing.

FINDINGS

There are numerous features of the home and neighbourhood that are highly desirable for tenants who want to stay and those who would consider moving. This included in order of priority: having good security; being close to the doctor and shops; having family/friends stay over at their home; a home without stairs; and help with mowing.

There are some marked differences for the tenant cohort who would consider downsizing. The transitioner cohort were more interested in having a modern home and having a smaller home, than the overall cohort. They are more likely to feel that their current dwelling does not meet their present needs (12.7% against 4.6% for all interviewees). These potential movers were less attached to place and they had lived in their residences for shorter periods than the rest of the cohort. For the potential transitioners, 63.6% felt that the size of their home was the right size for their needs and 27.3% found that the size of their home was too big for their needs. This is contrary to the total sample, with 81.5% of people satisfied with the size of the home, and only 10% finding the home too large. One reason for the generally high rate of satisfaction with the current home could be fear of forced relocation. That is, expressing satisfaction with the current home could be related to a strong desire to 'stay put'.

Factor loadings were extracted from the principal component of the total sample, and the transitional sample (correlated and oblique). This was based on the importance of selected household and neighbourhood features. For the two cohorts, factors such as being close to transport and being in the Logan area loaded above 1.0 factor, factors such as being close to shops and doctors, and having good security, loaded between 0.6 to 0.83 for both cohorts. There were however, some differences in the loading patterns for the two cohorts, and this is because some factors become apparent when moving becomes an option. For example, in the total sample, the importance of 'having a pet', loaded with being in the Logan Area and 'having a home with no stairs', while for the potential transitioners, 'having a pet' and 'having a garden' loaded with 'having a more modern home'. The most significant difference across the cohorts, was that 'having a smaller home' had a high loading (0.9) for the transition cohort, compared to a negligible value for the total sample.

What is evident from the data, is that those who are willing or likely to move, have the same core interests as the total sample. They are as interested in the Logan area, being close to family, having accessibility and security as the rest of the cohort. The key difference appears to lie in the quality of the dwelling itself. This means that for older social housing tenants to be inclined towards moving, the quintessential elements from the literature, such as support networks, transport, accessibility and familiarity have to be fulfilled, as well as delivering housing options that are more responsive to their needs such as smaller more modern homes. Having good security, being close to the doctor and importantly, having room in their home for family members to stay over were significant features for the potential transitioners.

What Might Motivate Relocation

For the potential transitioners, the conditions that will motivate relocation are (Brisbane Housing Company, 2017):

Access to Support

A clear majority of potential transitioners (90%) responded that having access to support services close by was a somewhat to very important feature of any future housing and 64% felt it was appealing to have those services on the same site as their home.

Modern Home

A significant 62% of potential transitioners preferred modern accommodation.

No Stairs

A high 91% of potential transitioners indicated that they would prefer a house with no stairs in the future (82%).

Guests

The Data Report indicated strongly that respondents used the space offered by extra bedrooms to regularly accommodate guests (93%) and that an important feature of future housing options would be the ability to continue to do so (98% of potential transitioners and 94% overall).

Pets

Almost all of the potential transitioners identified that having a home that could accommodate pets was somewhat important to very important.

PUBLIC HOUSING POLICY IMPLICATIONS AND CONCLUSION

While older Australians are not necessarily averse to moving, the benefits of moving must outweigh the perceived risks involved. The older social housing tenants who are inclined to move, are those that do not feel that their current home will meet their future needs, in particular those who report failing health and lessened physical mobility.

This research has highlighted the need to combine efforts at improving social housing, with a down-sizing approach based on the fundamental needs of older Australians. This would mean delivering social housing in multiple locations, to give such tenants options within their existing social networks, and it would also mean delivering affordable solutions, to minimize foreseeable risks, as well as incentivizing those that are relatively content, with improved dwelling attributes.

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REFERENCES

Brisbane Housing Company and Churches of Christ Queensland. 2017

Cutchin, M.P, 2005, ‘Spaces for inquiry into the role of place for older people’s care.’ Journal of Clinical Nursing, vol. 14, no.2, pp. 121–129.

Judd, B, Bridge, C, Davy, L, Adams, T, Liu E 2014, Downsizing amongst older Australians, no.214 Australian Housing and Urban Research institute, viewed 16 November 2016

Moore, Jeanne. 2000. "Placing Home in Context." Journal of Environmental Psychology 20 (3):207-17. doi: 10.1006/jevp.2000.0178.

Olsberg, D & Winters, M 2005, Age in place: intergenerational and interfamilial housing transfers and shifts later in life, no.88 Australian Housing and Urban research Institute, viewed 16 November 2016,

Peace, S. M, Holland, C, & Kellaher, L 2006, Environment and identity in later life. New York, Open University Press.

Stimson, R.J & McCrea, R 2004, ‘A push- pull framework for modelling the relocation of the retirees to a retirement village: The Australian Experience’, Environment and Planning A, vol. 36, no.8, pp.1451-1470.

Wiles, J.L, Allen, R.E.S., Palmer, A.J Hayman, K.J; Keeling, S & Kerse, N 2009, ‘Older people and their social spaces: A study of well-being and attachment to place in Aotearoa New Zealand’, Social Science & Medicine, vol.68, no.4, pp.664-671.

Wiles, J.L, Leibing, A, Guberman, N, Reeve, J & Allen, R.E 2011., “The Meaning of “Ageing in Place” to older People”, The Gerontologist, vol.52, no.3, pp.357-366.

SOCIAL HOUSING IN MYANMAR: ISSUES AND WAY FORWARD

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Abstract
Globally, both developed and developing countries are trying to be better in social housing provision. However, high poverty level and increased population are the major challenges for the government in developing countries. Myanmar is also facing the same problems; the government is in an emergency to provide the housing for citizens, especially in its most rapidly growing city of Yangon. The government has been planning to construct the "one million housing project" since 2011, which is expected to be accomplished by 2030. However, this target was not met for the first five-year fiscal plan. It is a question among the citizens whether the government will accomplish such a project in time. This paper was aimed to identify the current issues of social housing provision in Myanmar, and to identify some possible coping strategies. This was achieved through a systematic review of literature and a series of interviews with selected individuals who were involved in social housing in Myanmar. The findings highlighted some key issues in Myanmar social housing industry and its provision, and recommends possible approaches to rectify the problems.

Keywords: Social housing in Myanamar; Affordability gaps; Issues of social housing industry.

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INTRODUCTION

Myanmar public housing provision was established in 1951 and totally 101,136 housing units have been provided in 2018. It has been 67 years that rental, low-cost, middle-cost and high-cost housing were provided to citizens across the country, especially in Yangon. Yangon, the largest economic city center of Myanmar, is composed of 33 townships and has a population of about 8 million in 2017; it was about 5.2 million in 2014 (DOP, 2015). Because of increasing urban population, housing shortfall is inevitably encountered. Myanmar government has announced "million homes plan" to fulfil the housing need for its citizens. The government housing department, Department of Urban and Housing Development (DUHD) has planned to provide 20 percent of total targeted housing units and 80 percent of housing need to be provided by the government and private sectors.

However, in the last fiscal five-year from 2011 to 2015, the total housing units provided by DUHD in the period of five years was not met the targeted five-year fiscal plan. Because of this, the main questions are: (1) "is the targeted housing units are actually fulfilled housing needed?" (Myanmar Times, 5 April 2017); and (2) "whether the targeted housing units could be accomplished on time?". With respect to the identified issues, a series of interviews were also conducted with responsible persons in the social housing sector to gain deeper understanding into the identified issues. Based on the results, this paper recommends the possible solutions to attain better social housing industry in Myanmar.

SOCIAL HOUSING AND ITS CHALLENGES

Overview

Social housing is defined as "houses and flats that are owned by local government or by other organizations that do not make a profit, and that are rented to people who have low income" by Cambridge dictionary. Social housing can alternatively be used as public housing. Social and public housing are affordable housing; they are delivered at affordable prices to low-income families. Government and non-profit organizations are normally providing social housing to certified low-income people. Social housing is home for poor citizens who are struggling with their accommodation cost. Social housing is typically delivered by government allocation scheme. The main function of social or affordable housing is to provide housing with reachable prices for the poor. (Shelter in England, 2018)

Social housing is an interesting topic in many different fields such as political and economic (ideology), civil (engineering), environmental, anthropology and even in psychological fields. Development of social housing provision depends on political status of the country and housing policy intensely. Successful social housing provision and economic development of the country are correlated. Moreover, housing industry is a strategy to develop the country's economic and "housing sector needs to be given serious consideration in economic growth strategies" (Godwin, 2006). Likewise, quality of social housing effects on social and health of the residents. A survey showed that "the social and health outcomes of managed housing upgrade programme are predominantly positive". (Wouter et al., 2017)

Global Social Housing Challenges

About 330 million households in urban area are unaffordable housing rental cost across the world (McKinsey Global Institute, 2014). Their normal consuming such as food, schooling for children, transportation, and other social expenses are considered to be 70

percent of their income whiles the remaining 30 percent of income is for accommodation cost. However, 30 percent of their income is still out of reach the prices of housing and affordable gaps also can be seen in both developed and developed countries. Cities across the world struggle with the challenges of providing low- and middle-income families and the housing provision for the poorest people. Local governments and non-profit housing associations are distributing affordable housing while they are finding better solutions to narrow down affordable gaps.

Due to the persistent challenges faced by government worldwide, research has been conducted to identify possible approaches for successful national social housing deliveries. McKinsey Global Institute (2014) carried out a study to address the global affordable housing challenges and suggested the following four factors that can narrow down the affordability gaps:

1. Land – finding new lands at appropriate location and reasonable prices. Location must be easily accessible with the society. Land cost is the most important factors in reducing the housing costs.
2. Development – construction methods by industrial approaches and value engineering are also crucial factors in reducing the construction time and cost up to 30 percent and 45 percent respectively. Furthermore, construction cost can also be saved by applying advanced procurement and advanced construction technologies.
3. Operation and Maintenance – Establishing efficient rules and good governance can eliminate the operation and maintenance cost, for example, improving energy efficiency and partial purchasing by home owners.
4. Financing – Underdeveloped financing system, unregistered works of low-income families and poor banking system in developing countries are the challenges to attain financial assistance for tenants. Rental housing instead of ownership will be more affordable for low-income household.

Akanbi et. al. (2017)'s research on critical success factors for achieving sustainable social housing proposed the following economic success factors:

1. Creating "affordability" for people by providing subsidized housing, social rental housing and mortgage system.
2. Good governance is a key driver to boost the economic growth to support housing provision adequately.
3. Supplying "adequate funding" by governments or private sectors is an unquestionable success factor for sustainable housing provision.
4. "Economic design" must be well organized to eliminate the future maintenance cost by providing mixed development and "efficient use of resources" to reduce the expansion cost.
5. To meet the needs of social housing, apply "appropriate technology" for minimizing waste, conservation environment and the refurbishment.
6. "Efficient management" is also a way of alleviation the unnecessary costs that makes more profit for stakeholders.
7. Providing amenities and infrastructure to social housing will be promoted through "efficient economic planning".
8. "Effective policies and legislations" drive the efficient provision actives of social housing such as delivery systems, procurements and contracting.

Lessons Learned from the Selected Countries

In this section, lessons learned from four countries are carried out and the successful strategies are enumerated. Singapore, Japan and Thailand are selected to carry out lessons learned in this study. Japan and Singapore are developed countries and they have successful background and experiences in public housing provision. Thailand is a neighboring country for Myanmar and also it is a leading developing country in Southeast Asia Region.

In the history of housing industry of Singapore, politics played a key role in making the successful policies. The selected self-government supported the housing association with legal power and effective policies to fulfill its commitment "housing provision for all citizens" (Beng H. C., 2013). Social housing provision was successful in Singapore by the support of its government because having legal power is key factors in housing delivery systems. (Chua, B. H., 1997). For example, in 1967, Land Acquisition Act allowed Housing Development Broad (HDB) to use the legal powers for land acquisition to make redevelopment of slum more quickly (Urban System Studies, 2015).

Japan was not always successful in the history of public housing provision. They have an experience of "collapse of the property bubble" in 1990s although they were successful in housing restoration. It effected the economy negatively and made Japanese people to loss their confidence unrelentingly. Moreover, decrease of population with lack of young people and deflation are the factors to make that issue getting worse (Masahiro K., 2016). Policy reaction to address the collapse of the bubble and detecting to prevent forming the bubble are the main factors in the successful history of Japan social housing industry.

Public housing has been provided in Thailand more than 40 years. It is comparatively later than Myanmar housing provision. However, National Housing Authority (NHA) has provided 729,048 units until 2010 (NHA, 2013). Thailand has also an experience in accomplishment of "one million housing project" in (2002-2011) and Baan Eur Arthon Project has delivered 600,000 units over the period of 5 years. The government of Thailand provides subsidies in the amount of eighty thousand baht per unit for the cost of construction of public utilities in 2003 to reduce the affordability gaps (NHA, 2018). Thailand social housing provision was successful because of adequate financial funding supported by government. Public housing provision in Thailand keeps steadily increasing under the good management of NHA.

SOCIAL HOUSING IN MYANMAR

Affordable Housing Need in Myanmar

The population of Myanmar is increasing with greater urban population, from 35.3 million in 1983 to 51.48 million in 2014, nearly doubling over the period of 30 years (DOP, 2017). In urban areas, population has increased naturally and due to migration from local and foreign countries. As a result, urban population growth has dramatically increased, necessitating an urgent need for housing provisions to accommodate the demand.

According to 2014 census, the number of housing in Myanmar increased from 6.5 million in 1983 to 10.88 million in 2014. "Based on an estimate number of homeless people and those living in other collective quarters, and the number of low-income people with deficient living conditions, a core housing need of 3.8 million units was estimated for the country" (DOP, 2017). It is expected to reach 15.68 million housing units for 70.56 million people in 2040. Therefore, additional housing needed will be 4.8 million units if

it is assumed to be 4.5 person per housing units (Myanmar Times, 10 Aug 2017). Current housing need based on 2014 census and expected housing need in 2040 is illustrated in Figure 2. According to the results, current housing provision plan for low-income people is not enough for all to meet the aim of a Government Policy; “Adequate housing for all citizens”.

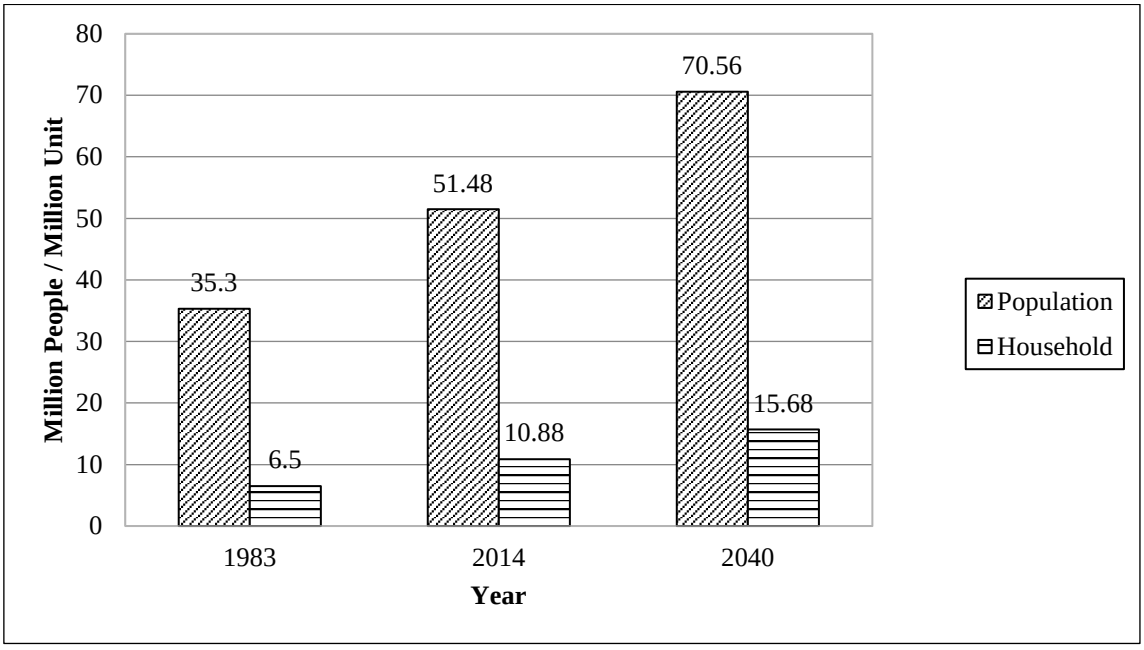

Figure 2. Expected Housing Need by 2040.

Housing Provision in Myanmar

To accomplish the provision of one million units, twenty percent of this plan will be constructed by DUHD, and 80 percent will be constructed by government and private sector. Twenty percent of one million housing units (i.e. 200,000 units) to be constructed over the period of 20 years. Total housing provision and housing provision by DUHD are shown in Table 2.

Table 2. Five year course

No.	Plan	Year	Total Housing Provision	Housing Provision by DUHD
1.	The first five-year plan	2011-2015	0.10 million	20,000
2.	The second five-year plan	2016-2020	0.18 million	36,000
3.	The third five-year plan	2021-2025	0.30 million	60,000
4.	The forth five-year plan	2026-2030	0.42 million	84,000
Total		2011-2030	1 million	200,000

In Myanmar public housing provision history, although it was since 1951, housing associations has provided public housing in the number of 101,136 units over the period of 67 years. Only 69,280 units were delivered over the period of 59 years (1951-2010) and then housing provision was dramatically increased after starting “million homes

plan". It reaches the number of 31,856 units in the course of eight years. However, rental housing provision for poorest citizens is still underdeveloped and comparatively less than the ownership.

Table 3. Myanmar Social Housing Provision.

No	Periods	Rental		Ownership			Total	Remark
		Rental Housing	Staff Housing	Low-cost	Mid-cost	High-cost		
1	1951-1961	6,601	-	-	-	-	6,601	Before "million homes plan"
2	1962-1988	3,393	7,637	-	-	-	11,030	
3	1989-2010	-	73	3,448	45,655	2,473	51,649	
4	2011-2015	1,424	3,180	4,376	3,748	1,210	13,938	first five-year plan
5	2016-2017	-	2,308	1,888	1,792	16	6,004	second five-year plan
6	2017-2018	-	2,310	6,992	1,069	1,543	11,914	second five-year plan
Total		11,418	15,508	16,704	52,264	5,242	101,136	

Source DUHD

According to this data, in the first five-fiscal year (2011-2015), housing provision missed the targeted first term plan. Although the housing provision did not meet the demand, some affordable housing units were unsold (Myanmar Times, 20 Oct, 2017) because the housing prices are unreachable for low-income families. So-called affordable housing prices are between MMK 11 to 30 million, which is nearly the same with the market prices of other apartments constructed by for-profit private sectors. (Eleven Myanmar, 30 September 2015).

In the period of second term plan, housing production was dominantly raised in 2017 due to the increased number of low-cost housing provision. In the period of 2016 to 2018, total housing provision was 17,918 housings, which is nearly half of the second five-year fiscal plan. If the providers keep this rate, the targeted second term may be accomplished in time for second term plan. Surprisingly, there was no rental housing provision for citizens in the period of 2016-2018 while poor citizens are expecting the rental housing that they can afford.

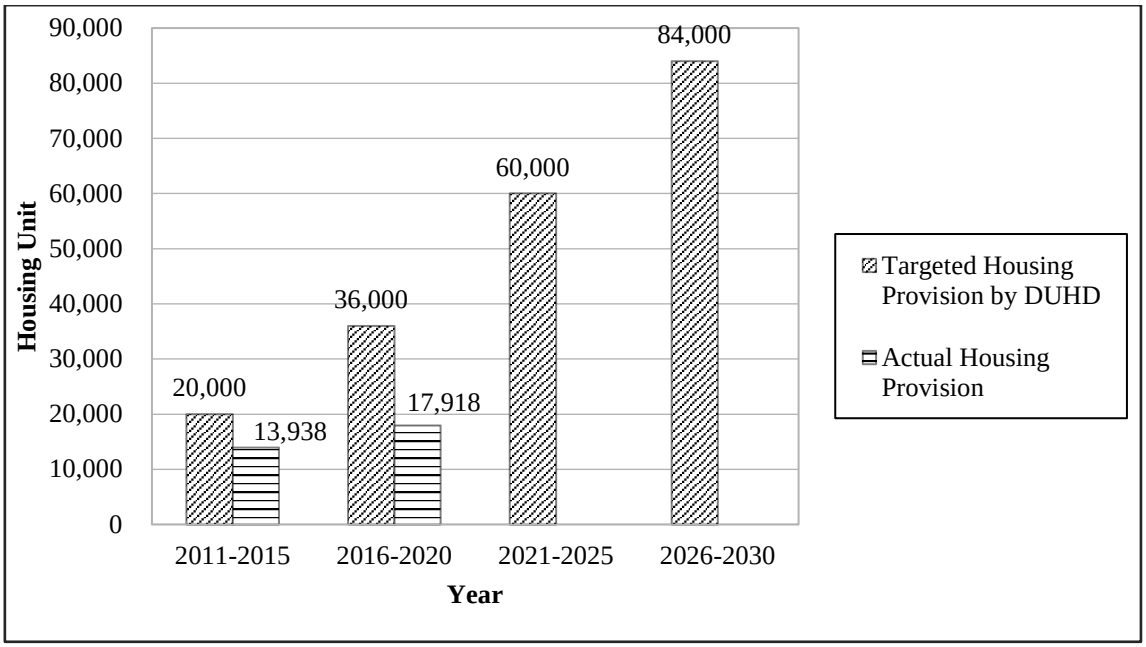

Figure 3. Targeted housing Provision and Actual Housing Provision by 2018.

Myanmar Housing Policy Evolution

Yangon, the largest commercial city in Myanmar, was a seat for colonial government. In the era of pre-independence, Yangon was urbanized by the British colonization. Myanmar public housing provision has established after Myanmar was granted own government. In 1951, "Nation Housing, Town and Country Act" has established and started providing social rental housing. Private sectors participation initiated in housing delivery in 1980's. Over the period of 6 decades, Myanmar was under the authority of military rules and the country's economic sectors including construction sector were underdeveloped.

Since 2011, Myanmar has been engaged in democratization, and promoting the economic development. DUHD has committed a National Housing Policy in order to implement the Government policy: "To upgrade living standards and provide adequate housing for all the citizens" and the housing policy "million homes plan". This plan began in 2011 at the time of previous government. However, "a codified housing policy in Myanmar has largely been lacking until November 2014" (DOP, 2017). The chronology of Myanmar housing policy evolution is demonstrated in Figure 3.

National Habitat Report (2016) described "The National Housing Policy aims to transcend the confine of government-funded public housing construction influence policies of allied sectors in Myanmar". Therefore, the actors and developers can participate in the provision at an appropriate scale. However, both domestic and foreign investment had some barriers such as high taxes and restricted policy. In the end of 2017, government released Foreign Investment Policy and clarified Condominium Law to attract the foreign investors. However, the government has not reduced the construction taxes yet, that high rate of construction tax is one of the barriers for private developers.

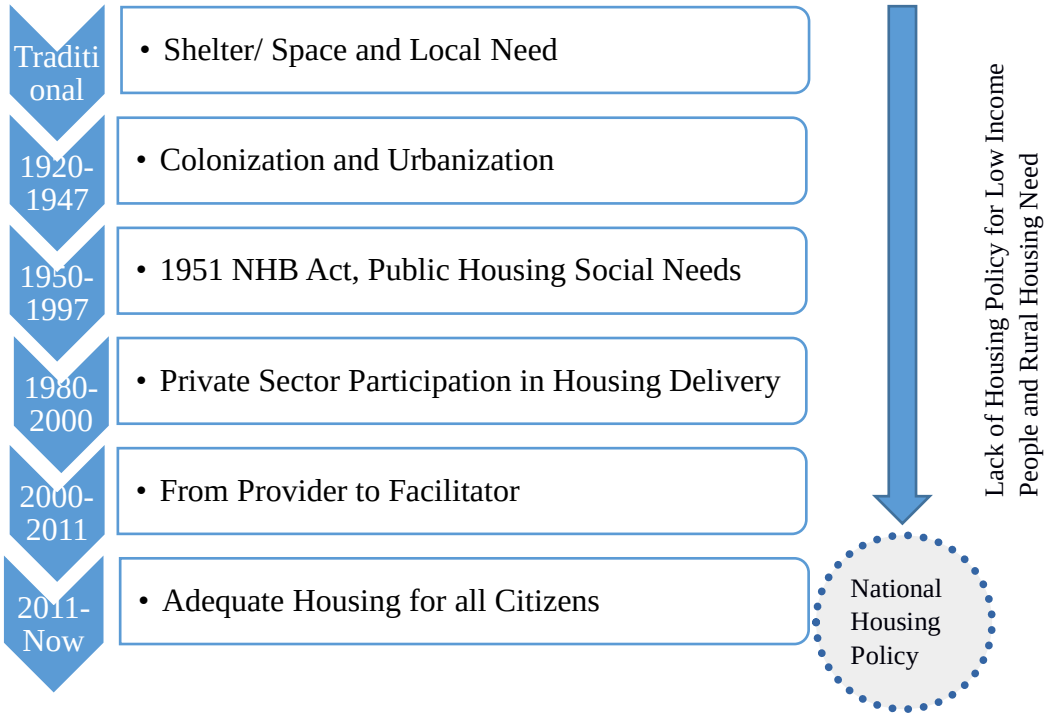

Figure 3. Illustration of Myanmar Housing Policy Evolution. (Japan-OECD)

Regulatory Bodies of Myanmar Social Housing Construction

Myanmar social housing construction industry is divided into two categories: government and public-private sectors. Ministry of construction (MOC) and its department DUHD are providing 20 percent of targeted plan and public-private sector provide 80 percent of targeted plan. Myanmar construction sector is overseen by the Ministry of Planning and Finance (MOPF). The previous government planned to supply one million housing units to the citizens but the actual provision did not reach the targeted plan (Myanmar Times, 10 March 2017).

Industry bodies, including the Myanmar Construction Entrepreneurs Association (MCEA), collaborate with the government to help develop construction policy. MCEA formed Myanmar Construction Development Public Co.,Ltd.(MCD) in 2015 and other public company - Yangon Metropolitan Development Company (YMD), formed in 2017 - will start constructing the rental housing for government staff and low-cost housing for government staff and pensioners, in 2018.

Material Usage, Technology and Standard

Myanmar constructions are mostly reinforced concrete buildings and steel. Precast buildings are used for some high-cost and middle-cost housing. Most of low-cost housing methods are traditional housing techniques and materials available in local areas. Further, there is no standard for public housing to meet the minimum required qualities.

Myanmar is on the way to integrate the quality of housing with the assistance of experienced foreign countries. To improve the design and quality of housing, MCEA signed with Surbana Jurong, a Singapore based engineering consulting agency and JICA form Japan to get the help for advising a prototype for low- cost apartment design.

Housing Finance Mechanism

Social housings are delivered by DUHD with long term mortgage system for low-cost housing. Low-income families can buy a housing by opening account at the sub-

government bank - Construction and Housing Development Bank (CHDB). They need to save money in that account. If the amount of saving reaches 30 percent of housing price, they can try the lottery in order to buy a housing, the remaining 70 percent of housing prices will purchase monthly with mortgage system. The length of mortgage system is 8 to 12 years with interest rate of 12-13 percent, which rate is too high for low-income families and it makes the original prices double after years.

There are 24 local banks in Myanmar which are interested in investing the low-cost housing, however, they encountered difficulties such as unbanked and unregistered informal works of low-income people and there is no "Apartment Law" that grantees the ownership of the residents. Now, they are planning to support non-collateral Construction Loans for small and medium size contractors. Government is also trying to fulfill the financial need housing by taking a loan of 15 billion Yen from Japan with small interest rate of 0.001 percent over a loan term of 40 years.

Affordability

According to 10,000 Household Survey by JICA 2013, 59% of monthly household income in Yangon is between MMK 100,000 to 300,000 (low-income) and 18% is under MMK 100,000 (poor). It means low-income families occupy the 59% of total households and poor families do 18% of total households. Total urban housing need in Myanmar is 0.07 to 0.1 million units annually, therefore, number of low-cost housing need is 40,000 to 60,000 per year (59% of total housing need) and subsidized housing need is 13,000 to 20,000 units per year (18% of total housing need). (DUHD, 2017)

Current provided housing prices and purchase system (30 percent down Payment and 70 percent loan) is out of reachable prices for low and poor families. Even lowest housing unit is need to purchase more than MMK 100,000 per month. That price is more than 30 percent of household income for average low-income families.

METHODOLOGY

Methodology used in this paper is qualitative analysis and can be divided into two parts. The first one is reviewing secondary documents such as newspapers, reports, and publication to identify the current status and issues of social housing in Myanmar. The other part is interpretation paradigm to explore the underlying reasons and barriers to provision of social housing. This part is carried out by interviewing responsible persons from housing associations.

RESULTS AND DISCUSSION

Four participants, two interviewees from DUHD and two interviewees from MCEA were chosen for making interview. Interviews were carried out by partially constructed questions based on the guide line of recommended solutions that mentioned above. Moreover, these interviews explored the underlying reasons and problems that they encountered.

Participant 1 (P1) is a Managing Director at DUHD and has over 30 year experiences.
Participant 2 (P2) is a Deputy Manager at DUHD and has over 20 year experiences.
Participants 3 (P3) and 4 (P4) are Executive Committee members at MCEA and have 20 year experiences.

The participants were contacted by phone and also social media. The interviews took average 1 hour. The interviewing results are shown in Table 3 and discuss in below. In the table, "S" refers to satisfied, "UN" refers to unsatisfied and "NM" represents not-mentioned. If the participants discussed a factor in positive way, that factor was regarded as satisfactory. If the participants have an option on a factor in negative way, that factor

was regarded as unsatisfactory. Some factors were not discussed in the interviews or they do not have much attention on that factors. That factors were regarded as not-mentioned.

Table 3. Problems in social housing provision from Interviewing Results.

Barriers to Social Housing Provision in Myanmar	P1	P2	P3	P4
1. Land	NM	NM	NM	US
2. Development	S	NM	NM	US
3. Operation and Maintenance	US	NM	NM	NM
4. Financing	US	US	US	US
5.. Affordability	US	US	US	US
6. Good Governance	NM	NM	US	US
7. Adequate Funding	US	US	US	US
8. Economic Design and Efficient Use of Resources	NM	NM	NM	NM
9. Appropriate Technology	US	NM	NM	NM
10. Efficient Management	US	NM	NM	US
11. Provision of Adequate Infrastructure Services	US	NM	US	US
12. Effective Policy and Legal Framework	US	US	US	US
1. Mortgage System	NM	US	NM	NM
2. Financial Investment	NM	US	US	NM
3. Tax rates	NM	NM	US	US
4. Quality Control	US	US	US	NM
5. Social Housing Standard	NM	US	NM	NM
6. Efficient handling for Slum	US	NM	US	NM
7. Labour Efficiency	US	NM	S	US
8. Apartment Law	US	US	NM	NM
9. Portfolio Management	US	NM	NM	US

S-Satisfied, US – Unsatisfied, NM – Not mentioned

The first four factors are recommended by McKinsey Global Institute and number 5 to 12 are recommend by Akanbi O. O. et al. These 12 factors were initial factors that were used to guide the interviews. The participants discussed the current issues in Myanmar housing provision based on these factors. Nevertheless, all participants did not discuss about “Economic Design and Efficient Use of Resources”. The other remaining factors, No.13 to No. 21 are were pointed out by the participants that they experienced in housing provision and they are briefly discussed below.

1. Mortgage System – Myanmar government is providing mortgage system but the interest rate is still high. Participating the domestic and foreign banks could not start in near future because of informal works of low-income.
2. Financial Investment – unclear policy and unstable politics make confuse to the developer and foreign investors for investment in the local affordable building. They need apartment policy to grantee the ownership status. They are also barriers to attract the investors.
3. Tax rates – construction taxes in Myanmar is 30 percent of the building. It is one of the main barriers to construct housing for the developers.

4. Quality Control – MoC and DUHD is maintaining the quality of public housing. However, their investigation and quality checking is not effective because of lack of standard for public housing.
5. Social Housing Standard – this factors is the most governing factors for achieving better livable standard quality housings.
6. Efficient Handling for Slum – the government has planning to provide low-cost housing for the poor who live in slum area. To buy the public housing they need to show the certificate of living in slum, as a consequence, corruptions occurs to attain that certificate because of high demand. Efficient actions are urgently needed to handle that problem.
7. Labour Efficiency – to reduce construction time and efficient construction procedure, skilled labours play an important role. Some participants pointed out and they were not satisfied on the lack of skilled labours in Myanmar Construction Industry.
8. Apartment Law – Participants from DUHD discussed this factors as the crucial factors to attain the financial investment from domestic and foreign banks for developers and owners. Because this Law can grantee the ownership status of the resident that makes the residents easier to get the loan.
9. Portfolio Management – They still use hand drawing map in the government office and they also have weakness in the design documents for affordable housing.

According to the results, the factors are ranked by the number of unsatisfied participants. There are four first ranked unsatisfying factors that means all participants pointed out that these factors are issues of social housing provision. They are “financing”, “affordability”, “adequate funding” and “effective policy and legal framework”. Although government has been trying to narrow down the affordability gaps by long term mortgage system, the prices are still out of reach. The prices of housing are added by infrastructure cost and taxes because government’s financial allocation does not include for the infrastructure costs.

Moreover, they have difficulties in getting financial allocation from government; inadequate funding, lack of supporting infrastructure and long waiting time to achieve the financial allocation. Authorities are trying to set better policy because these policies do not much efficient on the current situation and problems. In current situation, people are grappling with rental accommodation fees and therefore they could not save 30 percent of housing cost for down payment. Provide more rental housing will be better way to attain the efficient housing provision.

“Quality control” and “provision of infrastructure services” are second high-ranked problems for Myanmar social housing. Currently, Myanmar is in very initial stage to establish third party consultants to control the quality of housing. MoC and DUHD are overseeing the quality of social housing, however, more qualified third party consultants are expected to comprise by the developers.

Other factors; “Good governance”, “efficient management”, “Financial Investment”, “tax rates”, “efficient handling for slum”, “Labour Efficiency”, “Apartment Law” and “portfolio management” are also underlying factors that need to be improved. While participants from government association DUHD discuss the lack of Apartment Law is a barrier to social housing provision, participants from private organization MCEA think there is a weakness on the governance.

CONCLUSION

The crucial current issues in Myanmar social housing provision are financial problems, efficient policies, rules and legislation. Financial problems such as affordability gaps, unreachable prices due to insufficient support of infrastructure and high taxes can be ratified by the efficient policies. Although, the successful housing provision can be brought by the background of country's economic. Provision efficient social housing can drive the development of the economic. Currently, housing delivering depends on the government's financial allocation. Private Finance Initiative, domestic and foreign investment to invest in rental housing will be the solutions of that problem. Required laws and policies should be codify efficiently as soon as possible. Policy makers should collect the evaluation of developers and end users to set the better and efficient policy.

REFERENCES

Akanbi O. O. et al. (2017).Critical Success Factors (CSFs) for achieving sustainable social housing (SSH). *International Journal of Sustainable Built Environment (2017)* 6, 216–227.

Beng H. C., (2013). Navigating Between Limits: The Future of Public Housing in Singapore. *Housing Studies, 2014*. Vol. 29, No. 4, 520–533,

Chua B. H. (1997). Political Legitimacy and Housing: Stakeholding in Singapore. *London, Routledge.*

DUHD (2017). Myanmar Urban Development and Investment Opportunities.

DOP (2015). The Union Report. *The 2014 Myanmar Population and Housing Census. Census Report Volume 2.*

DOP (2017). Thematic Report on Housing Conditions and Household Amenities. *The 2014 Myanmar Population and Housing Census. Census Report Volume 4-I.*

Godwin A. (2006). The housing and economic development debate revisited: economic significance of housing in developing countries. *J Housing Built Environ (2006)* 21:377–395

Masahiro K. (2016). The Housing Market and Housing Policies in Japan. *ADBI Working Paper Series.*

McKinsey Global Institute (2014). A Blueprint for Addressing the Global Affordable Housing Challenge.

Myanmar Times (10 Aug, 2017). "4.8 Million Housing Units Required by 2040". *Received from https://www.mmtimes.com/business/27200-housing-requires-2040.html*

Myanmar Times (5 April, 2017). "Will government meet target on low-cost housing?" *Received form https://www.mmtimes.com/business/25595-will-government-meet-target-on-low-cost-housing.html*

Myanmar Times (20 Oct, 2017). "Nearly 300 low-price flats in Shwe Lin Ban Unsold". Received form *https://www.mmtimes.com/news/nearly-300-low-priced-flats-shwe-lin-ban-unsold.html*.

Myanmar Times (10 March 2017). "Ministry aims 1 million housing units by 2030" *https://www.mmtimes.com/business/property-news/25267-ministry-aims-at-1-million-housing-units-by-2030.html.*

National Habitat Report (2016). National Habitat Report: The Republic of the Union of Myanmar. *The United Nations Conference on Housing and Sustainable Urban Development*, Quito, Ecuador.

NHA (2012). Living Green. *2012 Annual Report, National Housing Authority.*

NHA (2018). Project of National Housing Authority. *Received form https://www.nha.co.th/view/2/home #sthash.T6b3fbSo.dpuf*

Oxford Business Group (2016). Demand for public infrastructure and affordable housing in Myanmar drives construction growth.

Shelter in England (2018). Improving Social Housing. *Received from http://england.shelter.org.uk/campaigns_/why_we_campaign/Improving_social_housing/what_is_social_housing*

Wouter P. et al. (2017). Social and Health outcomes following upgrades to a national housing standard: a multilevel analysis of a five-wave repeated cross-sectional servey. Poortinga et al. *BMC Public Health (2017)* 17:927.

Urban System Studies (2015). Built by Singapore, From Slums to a Sustainable Built Environment. 1st Edition.

"EVERY DAY I FEEL BLESSED": EXPERIENCES OF NEW HOMEOWNERS EXITING PUBLIC HOUSING INTO AN AFFORDABLE HOUSING PROJECT IN MELBOURNE

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Abstract
The role of social housing in Australia is changing. From a focus on government-led provision of housing for working-class families in the years following World War II, social housing is increasingly considered a safety net or an interim option for only the most vulnerable households. Government policy and rhetoric now focuses on encouraging tenants to move out as soon as their financial situation allows it. However, many households that leave public housing experience substantially higher levels of housing stress due to a lack of alternative secure and affordable housing options in the private market. A 34-unit development undertaken by a private developer in Melbourne, Australia, presents a model to address this problem. The development, entitled the Melbourne Apartment Project (MAP), uses a developer-provided 'advance' to allow current social housing occupants to reduce their initial financial outlay. This paper provides insights from nine interviews undertaken with MAP purchasers who have moved out of public housing estates in inner-Melbourne. The research identifies experiences of home, the 'push' and 'pull' factors that influenced the decision to move out of public housing and the experiences of stress, pride, security and pragmatism as expressed by these households.

Key words: Public housing; homeownership; housing stress; affordable housing; housing satisfaction

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INTRODUCTION

The role of social housing in Australia is changing. The proportion of social housing, or below-market housing delivered by the state government or community housing providers in Australia, has reduced from a peak of 8 per cent of all housing stock in 1966 (Hayward, 1996) to just 4.3% in 2016 (Productivity Commission, 2017). The diminishing proportion of social housing has been accompanied by two key narratives; the view that social tenancies encourage 'welfare dependency' through a lack of incentives to vacate social housing and an equity argument that promotes targeting scarce housing resources to those in greatest need (Fitzpatrick & Pawson, 2014). Both narratives conceptualise social housing as a "pathway to independence" (State Government Victoria, 2012, p. 24) rather than a long-term destination. While social housing previously often served as a stepping stone to homeownership (Hayward 1996), this pathway is significantly more challenging in contemporary housing contexts (Wiesel 2014).

The lack of transitions out of social housing into homeownership is partially derived from the lack of affordable and secure housing options available to low income earners in Australia. The change in social housing has occurred alongside rapidly increasing house prices since the 1980s, driven by "historically low interest rates, an unprecedented period of continuous economic growth and strong levels of migration" (Committee for Economic Development of Australia, 2017, p. 6). These factors reduce the availability of appropriate 'exit points' out of social housing. In addition, governments have responded to high demand and limited availability for social housing by tightening eligibility requirements to access this housing type. The result is a process of residualisation, or a significant increase in the concentration of very disadvantaged households in social housing. These tenants often experience multiple vulnerabilities including physical and intellectual disability, barriers to employment, unsupported childcare responsibilities and substance abuse issues that preclude them from exiting social housing.

This paper will focus specifically on public housing, delivered and managed by the state. At present, there is often little incentive or opportunity for tenants to move out of public housing (Wiesel, Pawson, Stone, Herath, & McNelis, 2014). At June 2016, 27% of tenants had lived in public housing 10 – 19 years and 42% had lived in public housing more than 10 years (AIHW 2016). Tenants exiting social housing may receive some support in the form of Commonwealth Rental Assistance if they rent a property or First Home Buyer Grants and Stamp Duty Concessions if they purchase a property. However, once tenants leave public housing, the majority experience far higher housing costs in the form of market rental or mortgage repayments due to a lack of affordable alternatives (Wiesel et al., 2014).

One exception is the Melbourne Apartment Project (MAP), a 34-unit developer-led project in the suburb of North Melbourne in Melbourne, Victoria. The project blends a limited equity financial model with strategies that aim to increase the supply of affordable housing. MAP enables this by combining a homeowner's deposit with a traditional bank loan and a developer 'advance' to reduce participants' upfront purchasing costs and ongoing mortgage repayments. The project offered 28 or the 34 units to current tenants of social housing in Melbourne, with eligibility dependent on participants qualifying for a traditional bank loan and agreeing to vacate their existing unit in social housing.

This paper draws upon nine interviews with current tenants of the Melbourne Apartments Project to investigate their experiences of public housing and homeownership, and their motivations and housing aspirations. The paper begins with a brief literature review, highlighting existing research about affordable home purchase

programs aimed at low income households and experiences of public housing tenants entering homeownership. The paper then presents the methodology, introducing the case study project, MAP. The paper concludes with a summary of findings from the interviews and a discussion of their implications.

LITERATURE REVIEW

Australian public housing policy has a long tradition of encouraging public housing tenants to enter homeownership (Hulse 2010). This was predominantly achieved through sale of public housing rental stock to tenants, based on a taken-for-granted commitment to owner-occupation as the ideal and natural tenure form in Australia (Wulff 1992). An evaluation of a low-deposit, low-interest home loan scheme offered to low income Victorian households in the 1980s found increases in employment rates and significant financial benefits experienced by participants, influenced by strong housing price growth in the late 1980s (Wulff 1992). However, since the early 1990s government policy has predominantly focused on supporting first homebuyers to enter homeownership, regardless of their income levels (Hulse 2010). One exception are the Shared Equity schemes supported at a state and territory government level in ACT, Queensland, South Australia, Western Australia, Tasmania and Victoria (Raynor et al., 2017)These schemes are aimed at first home buyers and include income eligibility requirements but are not explicitly targeted at social housing tenants.

Existing research undertaken in Australia found a considerable proportion of social housing tenants wish to remain in social housing either permanently or many more years (Wiesel et al., 2014). Literature highlights several ‘push and pull’ factors that encourage exit from social housing. Push factors include difficulties with neighbours or unsafe neighbourhoods and lack of suitability of social housing dwellings. Pull factors include moving in with a partner, moving to live with a family member or aspirations to enter homeownership. Despite this, incidence of exits into homeownership has declined in recent decades (Wiesel & Pawson, 2015), with private rental the most common destination for tenants leaving social housing (Seelig, O'Flaherty, Haynes, & Han, 2008). Studies have highlighted the complexity of housing preferences and behaviours exhibited by public housing tenants, calling for greater analysis to explain motivations for exits (Seelig et al., 2008).

While homeownership has the capacity to deliver significant benefits to households, it is accompanied by risks, particularly for low and moderate-income households. Hulse et al (2010) canvassed this topic, arguing that benefits included; lower housing costs over lifetime; wealth accumulation via asset appreciation; personal autonomy and ontological security; safety, stability and participation opportunities; and social status derived from homeownership. Conversely, Hulse (2010) acknowledge risks of homeownership that disproportionately accrue to low-moderate households including; unexpected and unpredictable housing expenditures, risks of slow increase or a decrease in asset values; stress associated with financial outlays and spatial disadvantage based on relocation to cheaper, poorly-serviced areas.

METHODOLOGY

This paper is part of a larger research project designed to evaluate the Melbourne Apartments Project. This paper draws on nine interviews to investigate participant experiences of transitioning to homeownership.

Case Study:

The Melbourne Apartment Project (MAP) is a privately funded 34-unit apartment development in North Melbourne, delivered by Melbourne Omnibus Co. Pty Ltd. The developer made 28 units available to social housing tenants while selling or retaining the remaining six apartments at market rate to cross-subsidise the costs of MAP purchasers. The project offered a range of two and three-bedroom apartments. The project is a partnership between Melbourne Omnibus Co. Pty Ltd and the Melbourne City Mission and reflects a social mission focused on supporting the movement of high capacity social housing tenants into homeownership. MAP blends a limited equity model with strategies that aim to increase the supply of affordable housing. MAP enables this by combining a homeowner's deposit with a traditional bank loan and a developer 'advance' to reduce participants' upfront purchasing costs and ongoing mortgage repayments.

The financial structure is composed of three components. The first is a deposit. Participating homeowners need to provide a deposit of at least $25,000. Many of the homeowners in the pilot project were eligible for a First Home Owners Grant. The second is a regular bank loan to finance the cost to develop the apartment, including the cost of land, construction, holding costs, design and permits. These costs constitute approximately 63% of the market price. Each homeowner is assessed individually by a bank and must qualify for a loan based on their income, savings and credit history. Finally a MAP loan or advance covers the difference between cost and sale price, appraised at market value (approximately 37% of market price). Savings in real estate and marketing costs and financial savings due to MAP's charitable status are captured and then provided to the purchaser through the second loan or 'MAP advance.' The advance is not subject to interest and is only repaid when homeowner sells their property. Further, the repayable amount of the advance is reduced every year for the first four years to a total reduction of $60,000 (MAP, 2017).

Melbourne City Mission managed the recruitment of participants for this project. Information fliers were mailed to residents in public housing estates in inner Melbourne and the MAP team held information sessions on public housing estates to answer resident questions. The team targeted estates within 4km of the MAP site. Interested tenants submitted expressions of interest and were assessed based on their income, credit history, their status as a current title-holder on a social housing unit and their capacity to provide a $25,000 deposit. Participants were supported through this process by an employee of Melbourne City Mission and had access to a free session with a financial advisor to support their decision making.

The homeowners that chose to purchase a MAP unit reflect an extremely heterogenous group. They are not a representative reflection of public housing tenants more broadly as they self-selected into a group with an interest in pursuing homeownership and the capacity to meet eligibility requirements. 26 of the 28 households receive an income from employment, in comparison to just 7.6% in the broader public housing population (AIHW 2016). The residents all previously lived within 4km of MAP, with 50 per cent of households moving from public housing estates in North Melbourne or Flemington. There is a diverse range of family compositions and cultural backgrounds reflected in MAP, as shown in Table 1 and 2 (O'Rourke, 2017).

Family structure	**No. Of families**
Individuals	3
One parent with dependents	7
Couple w/o dependents	5
Couple with dependents	10
Other family arrangements	3

Country of birth	**No. of families**	**Country of birth**	**No. of families**
Vietnam	6	Cambodia	1
Ethiopia	5	East Timor	1
China	4	Fiji	1
Eritrea	2	Hong Kong	1
Australia	2	Russia	1
Sudan	2	Somalia	1
Afghanistan	1		

Interview Process

Interviews were conducted with nine MAP households, almost a third of all 28 households that took part in the MAP. Participants were recruited through a letter-drop at the apartment building. Of the nine interviews, five were conducted in person and four were phone interviews. Interviews ranged from 20 minutes to 60 minutes in duration. Five interview participants were female, four were male and participant's ages ranged from early thirties to late seventies. Interviews were conducted in March and April 2018, reflecting resident experiences almost a year after moving to the property in 2017. Interviews were conducted in a semi-structured format to allow ideas to emerge naturally and to provide opportunity to investigate unexpected themes.

The nine interviews revealed a range of experiences of public housing. Most interview participants were long-term occupants of public housing with four participants growing up in public housing with their parents and remaining in public housing in adulthood. Similarly, another two participants immigrated to Australia from Afghanistan and Eritrea and have lived in social housing since their arrival in Australia. A further two participants entered public housing as single parents when their children were born. One outlier was an older homeowner who transitioned from private rental into social housing for two and a half years before moving to MAP. Overall, all participants except one had lived in public housing over 10 years and many had lived in public housing for close to thirty years.

FINDINGS

This section recounts the key themes emerging from interviews with MAP homeowners. Interviews focused on the push and pull factors that motivated decisions to purchase a home in MAP. They also outlined key initial experiences of homeownership for occupants, including reflections on changing financial and tenure contexts and reflections on property design and location aspects.

Achievable, well-located homeownership

All MAP owners expressed a strong desire to own their own home. However, many had given up on home purchase until they saw the MAP opportunity. As one participant explained, "*without something like the MAP…it would never be…it would always be a dream*" (R1). Others described the deposit and mortgage repayments as 'realistic,' 'attainable' and 'concrete,' allowing them to continue to live their lives without putting themselves under too much pressure. For some, MAP represented an opportunity to remain in the community they had lived in for decades. Many framed their options as a choice between remaining in public housing or moving to outer-suburban locations, compromising their ability to access work, services and their friends. As one homeowner explained, "*I'm an inner-city kid, born and bred. My sister bought a house down in South Morang, in the outer suburbs. I'm not that kind of person… I was never even gonna consider buying a house in the suburbs"* (R2).

Multiple participants expressed their desire to stop paying rent, explaining that "*public housing rent is a waste of money*." Participants were motivated by the opportunity to build equity, provide security for themselves and their family in retirement and own an asset to pass on to children. As one participant explained "*it was achievable property ownership. I always wanted to buy. Also, because I adopted my niece, it was something to give to her as well. So it was something tangible that I could give to her long term… it builds that self-worth that you have got something. That you can actually say 'I own a*

place now'" (R3). Stories ranged from low-income households with long-term dreams of homeownership to higher-income households that hadn't really considered homeownership until the MAP opportunity presented itself.

The desire to exit public housing

Several interviewees recounted their desires to leave public housing due to safety considerations and their desires to have a home in which they could invite friends or partners. Many spoke fondly of their sense of community in public housing, reflecting on homes and communities they had lived in for over 15 years. As one homeowner explained, "*Flemington is like home – for 15 years is home. So I miss it. I miss it. But I am glad. It is just walking distance"* (R4). Despite this, there was a strong theme of tension and concerns for safety living within public housing. One resident described her current living situation compared to her previous environment in public housing; "*I am much more relaxed. I know it sounds weird, but it is just not that tension – I think the environment in Richmond was getting quite, not dangerous, but a bit more aggravated*" (R3). Another recounted waking her daughters at 5:30am each morning to watch her walk out to her car in case she was attacked while walking down the stairs. Another explained that they could now allow their oldest daughter to have a key and be in the apartment on their own without fear for their safety. Several participants explained that this issue was relatively new, reflecting that there had been an increase in drug dealers and 'problem neighbours' in recent years, rather than the emphasis on migrant families they'd experienced in their childhoods.

Managing finances and negotiating homeownership

MAP requires public housing tenants to vacate their public housing unit and transition into homeownership, allowing a new household to enter the vacated public housing dwelling. The interviews conducted in this research revealed substantially different financial situations across the participants. Most homeowners felt their financial stress had remained the same or even decreased since purchasing a home in MAP. For many, the mortgage repayments were similar to the amount of money they previously spent on rent as most were 'over-income' households paying market rent. For some, the change to a mortgage reduced their financial stress as it necessitated a more structured approach to assessing and managing their finances and was accompanied by a feeling of achievement in becoming a homeowner. For others, the transition to ownership instigated a new sense of financial responsibility. Two participants lived with a parent in public housing, contributing nominally to rent and/or bills. Moving into MAP moved the responsibility for housing costs from their parents to themselves, creating a substantially higher financial burden. However, neither interpreted this change in a negative manner. As one participant explained, "*maybe something about me or something about the generation that I was from, but I never truly felt like an adult…but because I'm paying off the mortgage on my own, I've definitely had to become really vigilant about my finances*" (R5).

Approaches to gathering deposits and securing loans was similarly diverse. One participant's daughter paid for his apartment outright without seeking a loan. For her, MAP was an astute investment and one that would support her father in retirement. Another participant explained that she had been saving money for years without knowing what to spend it on and consequently had a large deposit available. Conversely, many households explained the difficulties they experienced in saving a deposit and obtaining a loan. Some borrowed money from friends and family to reach the $25,000 target. Some

explained that they were rejected by several financial institutions due to their low incomes before eventually securing a loan.

Well-being and ontological security

Initial feedback on MAP is predominantly positive. Many reflected on their improved sense of safety, security and relaxation moving to MAP. One participant explained that she used to stay late at work whenever possible to avoid going home. Reflecting on the experience she explained, "*always I call my daughter and I say "I'm driving, I'm so happy I'm going to my house. Every day I feel blessed…It's such a nicer place to be"* (R6). Another homeowner explained "*actually moving in, it's been amazing. It just feels like we can- we can rest. That was… the biggest goal I wanted to achieve for my daughter"* (R7). These comments were predominantly reflections on feelings of achievement for entering homeownership and greater feelings of security and safety. Participants were similarly positive about the process of purchasing a home through MAP. All participants recounted that they felt supported throughout the decision-making process and felt comfortable asking questions whenever necessary. While many encountered challenges choosing a lawyer, navigating the home purchase process and securing a loan, all felt they had sufficient support to make informed decisions and feel confident in the process. Interviews revealed unanimously glowing reviews of the Melbourne City Mission worker who managed the recruitment process. MAP developed a white paper and briefed all major banks on their financial model before participants contacted them, a step that many felt greatly increased their ability to secure a loan.

Concerns and Program Design

While most feedback on MAP was positive, participants did raise several concerns. A common theme was concerns about 'loopholes' or people 'gaming the system.' For example, one resident explained that an apartment was immediately rented to several students. Another apartment was immediately sold upon settlement. These situations raised tensions in the building with one participant explaining, "*as a person who came from that, I guess, from social housing, we were all more grateful that we had this opportunity… But then you kind of feel like, 'are you slapping us in the face by selling your house so quickly?'"* (R3). Participants raised concerns that one of the occupants was the parent of several extremely wealthy children who could support them without this opportunity. Concerns that a particular resident had failed to vacate their social housing unit were also raised, although this claim was unsubstantiated.

Many participants commented that there was little interaction between neighbours and little sense of community, although this was rarely raised as a significant issue. One resident raised concerns about other households inviting friends and family into the building. For him, moving out of public housing meant moving away from gangs that used try to pick fights with him. He explained that those same people are now starting to frequent the neighbourhood and building. For him, "*they treat the building like it's the commission flats. Kids running around the building… They go to roof top, stomping on the tables"* (R8). This is a problem for the use of communal spaces and maintenance of the building. On the shared rooftop area "*we've got alcohol, you know, beer cups, cans, cream charges, balloons... All over the deck... I saw a little baggie. That is not something I wanna see in my building*."

DISCUSSION

This paper contributes to existing literature by providing a qualitative insight into why and how public housing tenants exit public housing into homeownership. Seelig et al.

(2008, p. 61) found that "exits from public housing in practice are not driven primarily or even substantially by (changes in) earned income levels, and that other factors dominate." This paper contributes to research investigating the 'other factors' that drive social housing exits. In line with previous studies, this study did not find a homogenous group of higher-income households exiting public housing in response to gaining employment. Participants ranged from a retiree with wealthy children, single mothers in unskilled jobs, a single woman with an adopted child, tertiary-educated adult children living with a parent and dual-income, low-income families with children.

Interviews reveal several 'pull' factors that highlight the importance of property ownership, the capacity to pass on an asset to children and a desire to remain within inner Melbourne. As discussed by Hulse (2010), homeownership has the potential to confer substantial benefits in the form of reduced long-term housing costs and the potential for wealth accumulation. These considerations were apparent in every interview conducted for this project. For most, an inability to save a deposit or meet mortgage repayments on a market priced property was a significant barrier. Similarly, participants spoke of their discomfort in navigating housing markets, real estate agents and auctions and their desire to secure a financially sound investment opportunity. Most participants mentioned that buying property in inner-Melbourne was completely unattainable for them and discussed their unwillingness to give up the benefits of inner-city living.

The MAP purchasers appear to be making rational decisions about their locational preferences, with reference to their financial capabilities. The availability of well-located, affordable and secure accommodation is central to their decision-making processes. Most residents retain strong connections to their existing communities, often returning to their previous homes for community gardening, access to friends and activities and connection to their cultural groups. Many do not drive and cited this as a reason they would not leave the inner city. The ability to walk or catch a tram to the public housing dwellings was strongly valued. The location of MAP, in a well-serviced inner-location, ameliorates the additional pressures often experienced by low income households that purchase in outer-suburban locations and become 'trapped in space' and suffer from lack of access to services and support networks as they have insufficient equity to move elsewhere (Hulse, 2010 p4).

The reference to safety and security as a 'push' factor, particularly amoung female interviewees, is a significant problem for public housing policy in Australia. The continuing residualisation of public housing is likely to exacerbate these concerns, reducing well-being and forcing residents to adjust their behavior to ensure their own safety. Unaffordable housing markets exacerbate this concern as residents hoping to leave a place for their own safety have little power to transfer within the social housing system (Wiesel 2014) and lowered capacity to access private market options.

MAP provides a more affordable pathway to homeownership for current social housing tenants. While most tenants stated that their financial position was unchanged or improved by the transition from renting to homeownership, interviews revealed accounts of precarious financial situations. For example, participants explained they had borrowed money from family and friends to pull together their deposits and were rejected by several banks before securing a loan. Another household discussed the challenges of securing a loan as an older, single woman. She explained that, while she could meet her repayments and pay her bills, there was very little left over to buy furniture or any other expenses. As she reaches retirement age, she will rely on her children to continue to pay her mortgage, highlighting a common theme of intergenerational support in this project. This tenant embodies increasing concerns about older people who continue to rent after retirement and their increasing experiences of poverty and lack of control or choice in where they

live (Yates and Bradbury 2010). Another participant similarly expressed previous experiences attempting to access a sufficient loan to enter homeownership, referring to the discrimination she had received in accessing finance as a single mother.

Interviews also revealed ethical questions about 'deserving' occupants and 'legitimate' uses of the apartment. Residents expressed concerns about purchasers who chose to immediately sell or rent their properties. They also mentioned households they felt took advantage of MAP despite being wealthy in their own right. While MAP's primary goal is the 'freeing up' of social housing for other 'deserving' households, these outcomes do raise questions about the application of this project in other contexts, particularly if they draw upon government funds. There is no covenant on the sale of these dwellings to ensure their affordability in perpetuity. Social housing in Australia is tightly rationed and paternalistic, placing little emphasis on tenant's choice, control, preferences or goals (Wiesel and Habibis 2015). A project like MAP, that places no caveats on home purchase beyond vacating a previous residence, clashes strongly with this system.

CONCLUSION

This paper presents interim results based on a research project evaluating the Melbourne Apartment Project. The study reveals substantial benefits enjoyed by participants, including pride in entering homeownership, greater feelings of safety and security and acknowledgement of the benefits or remaining within existing communities. As this study is conducted 10 months after occupation, it reflects a snap-shot of initial experiences, rather than a longitudinal study. Similarly, it does not present a control group of public housing occupants who did not choose to take part in MAP. It provides insights into the motivations behind moving into homeownership including desires to secure a worthwhile investment, stop wasting money on rent and leave unsafe housing conditions. Similarly, it reflects the predominant barrier to making this move earlier; unattainable or insecure housing options near existing communities.

This study found most residents have not experienced substantially heightened feelings of financial stress since moving into homeownership and still retain strong connections to existing communities. The study also found tensions around 'legitimate' applicants and 'fair' uses of apartments that may need to be addressed in future iterations of this model. Future research will conduct a second round of interviews in 2019 to assess longitudinal changes to homeowner experiences and perceptions.

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REFERENCES

Australian Institute of Health and Welfare. (2017) *Housing Assistance in Australia 2017*, Retreived from Canberra: https://www.aihw.gov.au/reports/housing-assistance/housing-assistance-in-australia-2017/data

Committee for Economic Development of Australia. (2017). *Housing Australia*. Retrieved from Melbourne: https://www.ceda.com.au/Research-and-policy/All-CEDA-research/Research-catalogue/Housing-Australia

Fitzpatrick, S., & Pawson, H. (2014). Ending Security of Tenure for Social Renters: Transitioning to 'Ambulance Service' Social Housing? *Housing Studies*, *29*(5), 597-615. doi:10.1080/02673037.2013.803043

Hayward, D. (1996). The reluctant landlords? A history of public housing in australia. *Urban Policy & Research*, *14*(1), 5.

Hulse, K. et al. (2010) *The benefits and risks of home ownership for low-moderate income households*, AHURI Final Report No. 154. Melbourne: Australian Housing and Urban Research Institute

MAP. (2017). *Melbourne Apartments Project - From social housing to home ownership (unpublished)*. Melbourne.

O'Rourke, M. (2017). *Melbourne Apartments Project (unpublished)*. Melbourne

Productivity Commission. (2017). *Report on Government Services 2017: Housing and Homelessness*. Retrieved from Canberra: http://www.pc.gov.au/research/ongoing/report-on-government-services/2017/housing-and-homelessness

Raynor, K., Otter, C., & Dosen, I. (2017). *Housing affordability in Victoria*. Melbourne: Parliament of Victoria Library

Seelig, T., O'Flaherty, M., Haynes, M., & Han, J. (2008). *Housing consumption patterns and earnings behaviour of income support recipients over time*. Retrieved from Melbourne: https://www.ahuri.edu.au/research/final-reports/118

State Government of Victoria (2012). *Pathways to a fair and sustainable social housing system*, Melbourne: State Govenrment of Victoria

Wiesel, I. and Habibis, D. (2015) *NDIS, housing assistance and choice and control for people with disability*, AHURI Final Report 258, Melbourne: Australian Housing and Urban Research Institute

Wiesel, I., Pawson, H., Stone, W., Herath, S., & McNelis, S. (2014).*Social housing exits: incidence, motivations and consequences*. Melbourne: Australian Housing and Urban Research Institute

Wiesel, I. & Pawson, H. (2015) Why do tenants leave social housing? Exploring residential and social mobility at the lowest rungs of Australia's socioeconomic ladder, *Australian Journal of Social Issues* 50(4), 397-417

Wulff, M. (2008). Home Ownership for Low Income Families: Key Findings from the Five Year Victorian Capital Indexed Loan Evaluation Study, *Urban Policy and Research*, 10(2), 6-16, DOI: 10.1080/08111149208551487

Yates, J. & Bradbury, B. (2010). Home ownership as a (crumbling) fourth pillar of social insurance in Australia, *Journal of Housing and the Built Environment* 25(2), 193-211

THE CASE FOR BUILDING IN ADAPTABILITY IN HOUSES

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Abstract
Housing space requirements for individuals and families change over time, as individuals age and families grow and decrease in size. It would thus seem appropriate that houses themselves should be built with adaptability features that facilitate this change in space requirements. The paper presents a built-in adaptability quantitative analysis, which incorporates the possibility that although adaptability exists it may not be called upon, depending on future circumstances. Two examples, extracted from Australian practice, are discussed: the first is the practice of extending a single-storey house to a second level in order to provide increased housing space perhaps for a growing family; the second is where a house too large for its occupants is divided into two smaller separable house spaces. The paper shows the range of circumstances over which building in adaptability is viable, that is the range over which it betters (financially, socially and environmentally) the form where no forethought to building in adaptability is given at the time of initial construction, but where subsequent adaptation still takes place, albeit with greater effort, cost and disbenefits. The paper will be of interest to those at the design stage of housing, both individuals and building companies.

Keywords: Adaptability; Flexibility; Housing; Valuation

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INTRODUCTION

People's needs and wants change over time. Young couples look to acquire a house, often basic because of financial constraints. As children arrive and children grow older, the house needs to grow in space. The children then depart to other accommodation, leaving the parents, who are now older and less mobile, requiring less space.

Associated with these life transitions, there is a need for different housing types. The Australian market deals with this in a number of ways. In terms of increased space, upward extensions are common, giving a two-storey house. In terms of reduced space, house divisions are possible, converting a single dwelling into a duplex, and enabling the sale or rental of one half of an asset. Both approaches allow house owners to stay in the neighbourhood with which they are familiar and which contains their friends, work, clubs and amenities.

It would then seem reasonable that, when a new house is designed and built, provision for extension and contraction be made, subject to demonstrating its viability. In this context, the paper gives a method for quantitatively valuing built-in adaptability or flexibility. The valuation is done in terms of a comparative analysis, where the difference between houses with built-in adaptability and business-as-usual houses (namely, no forethought to future adaptation) is calculated. The calculation can be done in monetary terms alone if the social and environmental disbenefits (Carmichael, 2014) are given a dollar value, while recognising that such conversions of social and environmental impacts are not without their critics. The calculation for adaptability needs to acknowledge future uncertainty, implying that a deterministic analysis will not be enough to inform. The calculation also needs to incorporate the possibility that future adaptation may not occur depending on the future circumstances of the house owner; expressed other ways, the house owner holds an option in the future to adapt or not adapt, or the house owner has a right to adapt but not an obligation to adapt.

The paper is structured as follows. Firstly, the background to built-in adaptability is discussed. A method of quantitatively valuing adaptability is presented. Two examples studies – a second storey extension and a house division – are discussed and parameter studies presented. Conclusions follow.

The paper will be of interest to those contemplating buying or designing/building a new house, or those selling new houses off-the-plan.

BACKGROUND

The current literature focuses predominantly on the adaptation of existing housing. By contrast, this paper focuses on thinking about adaptability at the design and construction phase of housing. Both the adaptation of existing housing and forethought on adaptability address the same interests, namely housing conversions with respect to interiors, exteriors and building volume or space (Till and Schneider, 2005). Only background dealing with built-in adaptability is addressed here, where it is seen that the number of published articles is much less than for the situation involving the adaptation of existing buildings (Gann and Barlow, 1996; Heath, 2001; Langston et al., 2008, 2013; Wilkinson et al., 2009).

The literature on designing-in or building-in adaptability or flexibility in housing naturally argues in favour of such thinking, but argues qualitatively (Gann and Barlow, 1996; Kendall, 1999; Slaughter, 2001). Building in adaptability is regarded as a sensible thing to do by the existing literature, but is not supported by any quantitative justification or analysis. Kendall (1999) argues that the extra initial cost of building-in adaptability is small, suggesting possibilities of open plan buildings with changeable façades and easily accessible services. Slaughter (2001) estimates that the extra initial cost of having

flexibility is insignificant, with figures of 1%-2% suggested, with possible design coming from prefabrication, over-capacity design and separating building subsystems.

The so-called 'universal design' (Karol, 2007; NCSU, 2013; Palmer and Ward, 2013), where buildings are designed as user-friendly for all persons of all ages and all degrees of mobility, is a related concept. Here, however, the design and structure stay constant over the lifetime of the dwelling. As with the built-in adaptability of this paper, it provides extended lifetime usage of dwellings, and allows for an extended pool of possible dwelling users over the dwelling lifetime. It has been suggested that such 'universal design' adds only small extra costs (NCSU, 2013).

Moffatt and Russell (2001) comment on alterability through design changes related to space layout, space usage and space expandability, to meet changed needs. See also Arge (2005). Over the lifetime of a building, this is argued to lead to lower total costs.

More generally, Schneider and Till (2005), Till and Schneider (2005), Guma (2008), Zhang (2010), Carmichael (2015, 2018), de Neufville and Scholtes (2011) and Carmichael and Taheriattar (2018) comment on the need to change conventional thinking to that of incorporating flexibility into initial building design, and the potential for cost and disbenefit savings over the life of a building. Flexibility is acknowledged in the literature as necessary to delay obsolescence in its various causes - physical, economic, functional, technological, environmental, social, or legal (Gann and Barlow, 1996; Slaughter, 2001; Schneider and Till, 2005; Till and Schneider, 2005; Greden, 2005; Wilkinson et al., 2009; Gosling et al., 2013). However, the literature gives no way of quantitatively valuing built-in adaptability or flexibility in housing; this is the subject of this paper.

VALUING ADAPTABILITY

To value adaptability, two forms are examined and a comparative or difference analysis is carried out. The two forms are:

- (A) built-in adaptability, where adaptability features have been designed and built in *ab initio*, with the view that adaptation may (but not necessarily) take place in the future depending on future circumstances. The house has built-in flexibility.
- (NA) non built-in adaptability (business as usual), where the house has been designed and built without adaptability features in mind, but where future adaptation may still be fortuitously possible, albeit with greater effort.

It is assumed that the benefits are the same for both forms, and hence only the costs and disbenefits need to be looked at.

Costs and disbenefits are financial, social and environmental. Financial costs refer to labour, materials and equipment used in the construction. Social and environmental disbenefits are those that affect stakeholders, and are associated with new construction and deconstruction. For workers this involves health, safety and employment. Neighbours are affected by disruption, pollutants, dust, noise and vibration. Owners are impacted through the inconvenience associated with temporarily vacating a house in order that it can be altered in the NA form. Environmental disbenefits include materials and energy consumption, equipment emissions, loss of embodied emissions, and waste generation during construction and deconstruction. Social and environmental disbenefits are converted to dollar values (Gilchrist and Allouche, 2005), though such a practice is not without its critics. Although from a strict accounting viewpoint, costs and disbenefits might be viewed as cash outflows, it is convenient in the following discussion to not attach negative signs to the costs and disbenefits, but rather be aware of their nature.

Form A involves financial, social and environmental costs and disbenefits at time $t = 0$, while form NA does not. At the time of adaptation, $t = T$, both forms A and NA

involve financial, social and environmental costs and disbenefits, but to differing extents because of the nature of the deconstruction and construction that occurs. Schematically, Figure 1 applies. All financial, social and environmental costs and disbenefits can contain uncertainty (Carmichael, 2014, 2016b). The value of T can be varied in order to establish the best time to adapt.

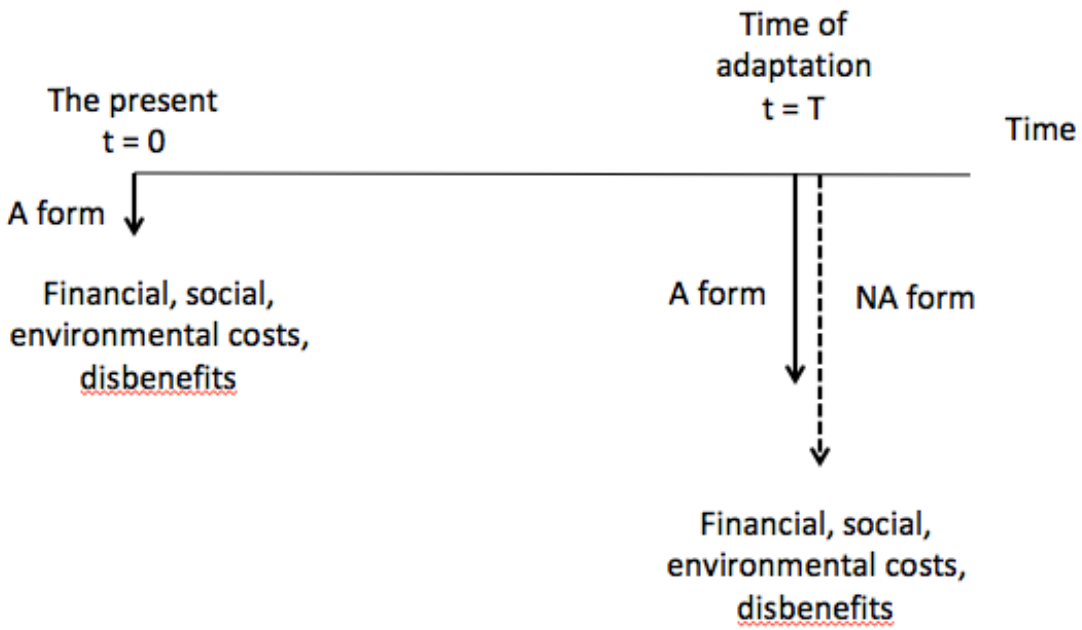

Figure 1. Schematic of the valuation inputs.

Given that adaptation at T will only occur if it is perceived as being worthwhile to the house owner, the value of having adaptability can be determined from an options analysis. The costs and disbenefits at time T are discounted to their present worths, such that the effective present worth is the present worth due to the costs and disbenefits associated with the NA form minus the present worth due to the costs and disbenefits associated with the A form. This discounting may be done by Monte Carlo simulation or through a second order moment analysis. The adaptability value follows from (Carmichael et al., 2011; Carmichael, 2014, 2016a),

$$\text{Adaptability value} = \Phi M \qquad (1)$$

where Φ is the probability P[PW > 0] (Carmichael and Balatbat, 2008), PW is the effective present worth, and M is the mean of the positive part of the effective present worth distribution measured from PW = 0. Any suitable interest rate may be used (including probabilistic rates), while acknowledging that uncertainty in the costs and disbenefits has already been incorporated in the analysis. Any suitable probability distribution for PW may be used.

This adaptability value can be compared with the upfront (t = 0) costs and disbenefits of the A form in order to determine viability. Viability is established if the adaptability value is greater than these upfront costs and disbenefits. In effect, the analysis looks at the trade-off between extra costs and disbenefits at t = 0, and the savings in costs and disbenefits at t = T. Where cheapest initial cost is sought by the owner, adaptability may

not be contemplated, even though the extra initial cost is minor if the house is properly engineered.

ADAPTABILITY

Adaptability may be designed and built into a house in many ways, and with creativity the extra cost and disbenefit impact can be minimised (Carmichael, 2013). In many applications, the labour and equipment costs will be no different to the situation where adaptability has not been considered. Some examples and issues involved in adaptable design are discussed here.

One to two storeys

Knowing that the ceiling of the one-storey house will become the floor of the storey above, timbers that can withstand floor loads can be used for the ceiling. These ceiling timbers could be covered with flooring sheets, and the roof mounted on this. With a roof designed to be reused (assuming the same footprint for both levels), the second level becomes one of raising the existing roof, and adding second level walls to support. Materials reuse is maximised, and waste minimised. There may be no need for the house owner to move out while new construction takes place. It is assumed that first level walls and footings are capable of supporting a second level. Room layout is chosen to facilitate the introduction of stairs and maintain good people movement around the house.

An alternative is that the first level be jacked up to become the second level, and a new first level built underneath.

Current practice in adding a second level is quite messy, usually involving the house owner moving out while deconstruction and construction takes place. New timbers are inserted on blocks to support the new second level, and this leads to a visually unattractive height between the ceiling below and the floor above. A new second level, including a new roof, is added and the old roof is discarded. Time on site at the time of adaptation is large because of the issues involved in changing something that wasn't designed to be changed. There is almost no materials reuse, but much waste. Stairs are inserted where it is possible to do so, but this may not suit the people movement in the house. The house always looks as though it has had a second level extension as an afterthought, and also is visually unattractive in the majority of modified houses.

Current renovation and addition/extension costs per square metre are nearly twice that of new construction. With a house designed for adaptation, the cost per square metre could be anticipated to be closer to that of new construction. This represents a considerable saving, and with social and environmental issues additional, it would make design for adaptation a better choice than the sustainability-unattractive 'knock-down, rebuild' that is promoted heavily in the media.

Single dwelling to duplex

The principal features of a duplex or semi-detached houses are that they are separated by soundproof and fireproof walls, and that they have separate entrances. To design for future division of a house thus requires minimal extra cost and disbenefit – the additional dividing wall material, and secondary entrances/exits. Room layout is chosen with two uses in mind – a single house owner, and two house owners. At time of adaptation, the separating firewall is made complete.

Without design for adaptation, the new construction (separating wall and entrances) can be messy, and the room layouts don't lend themselves to people movement.

The market

In principle, the market should place a higher price on a dwelling that has in-built adaptability features. It has value to a buyer, but how that value compares with the value calculated using Equation (1) would be unknown in any negotiation between seller and buyer.

Costing uncertainty

Commonly, new building work might be undertaken on a lump sum basis, subject to adjustments, which are possible in most contracts. Renovation and addition/extension work might preferably be done by builders on a cost reimbursable basis, because of the unknowns in the house being altered. Cost reimbursable work and final cost could be anticipated to have greater variability or uncertainty than lump sum work and final cost. An examination of Equation (1) shows that the option value increases with uncertainty. The more uncertain are the costs and disbenefits at time of adaptation, the higher the adaptability value. Methods for estimating costs and disbenefits in the presence of uncertainty are outlined in Carmichael (2006, 2014, 2018).

NUMERICAL STUDIES

Numerical studies are given for a range of differences between NA_T and A_T, time of adaptation, interest rate and uncertainty in the future estimates for NA_T and A_T. Here, NA_T refers to the collective costs and disbenefits of the non-adaptable form at time T, while A_T refers to the collective costs and disbenefits of the A form at time T. The following ranges in variables are considered:

$NA_T - A_T = \alpha A_0$, with the multiplier α: 0.5, 1.0, 2.0, 5.0

Time to adaptation (years), T: 2, 5, 10, 15, 20

Interest rate (per annum), r: 0.05, 0.1, 0.15

Coefficient of variation of $NA_T - A_T$, COV: 0.2, 0.5, 1.0

A_0 refers to the collective costs and disbenefits of the A form at time 0. The base values for the sensitivity-style calculations carried out here correspond with α = 2.0, T = 10 years, r = 0.1 per annum, and COV = 0.5.

In Figures 2 to 5, adaptability viability is plotted against these variables. Viability is here defined as the difference between the adaptability value (calculated from Equation (1)) and the collective costs and disbenefits at t = 0 necessary to achieve adaptability (A form). In Figures 2 to 5 it is the trends, which are important, rather than the absolute values, because collective costs and disbenefits have been unitised. Figure 2 shows, as anticipated, that the viability increases with the difference between the collective adaptation costs and disbenefits of the NA form and the collective adaptation costs and disbenefits of the A form. Figure 3 shows the decline in viability the further into the future adaptation takes place. Figure 4 shows the decline in viability with interest rate. Figure 5 shows the increase in viability with uncertainty in the collective cost and disbenefit estimates at time t = T.

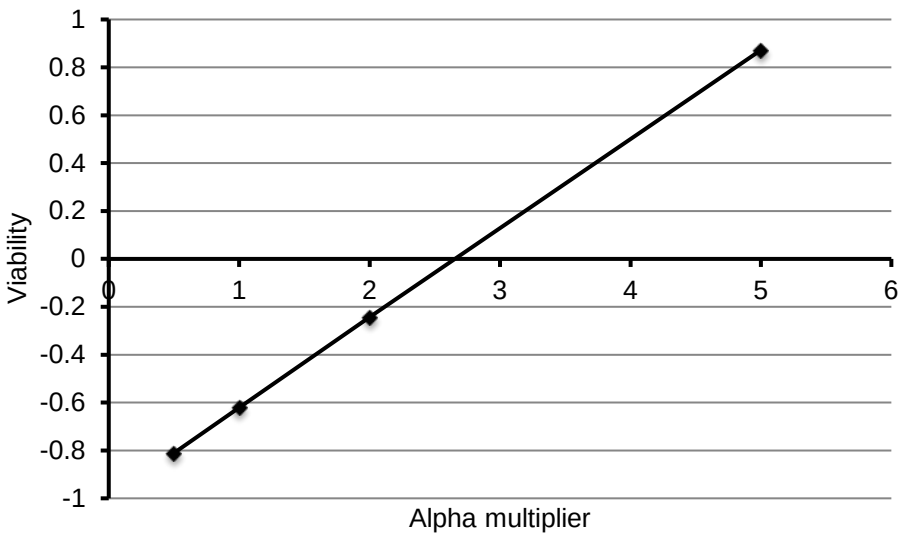

Figure 2. Viability of adaptability versus difference in adaptation costs and disbenefits at T.

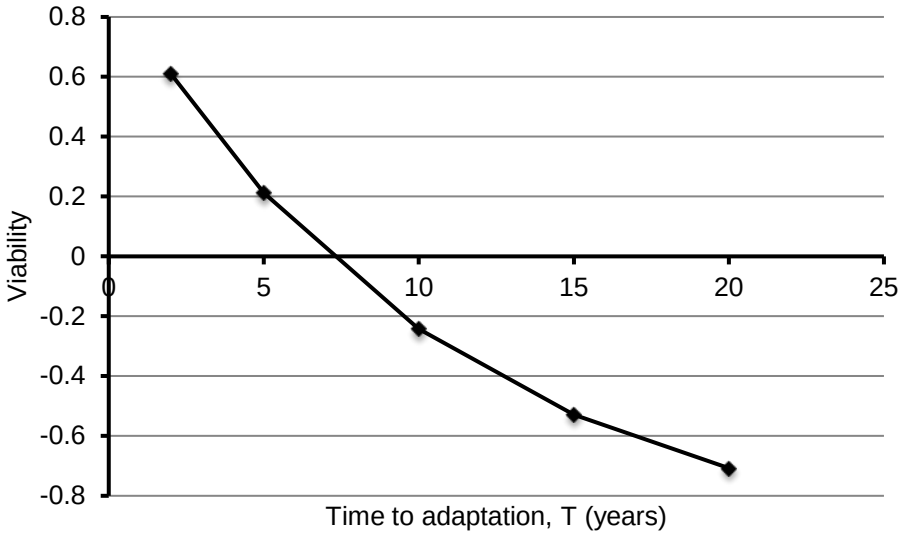

Figure 3. Viability of adaptability versus time to adaptation.

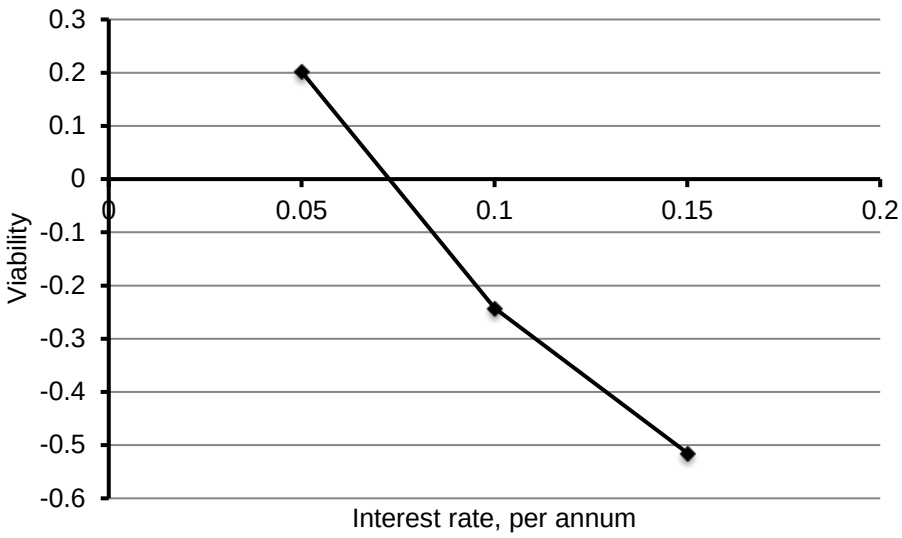

Figure 4. Viability of adaptability versus interest rate.

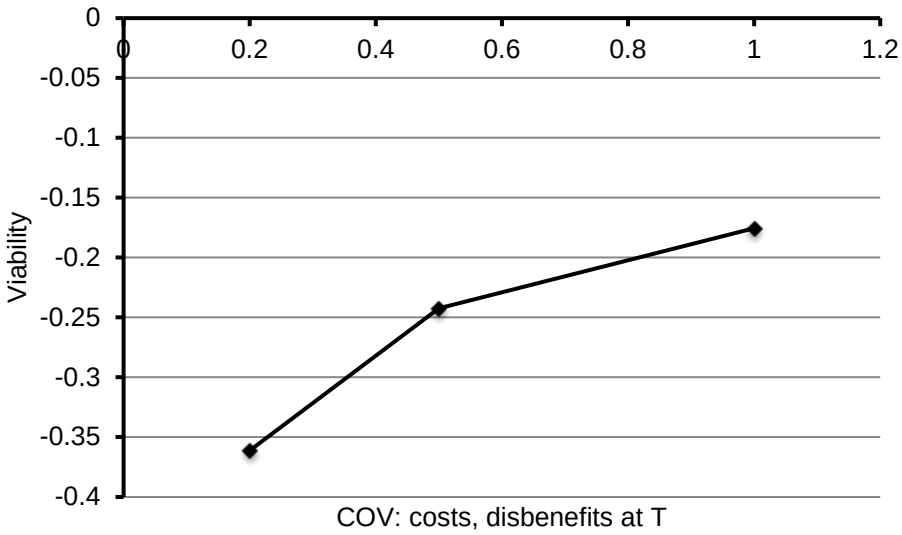

Figure 5. Viability of adaptability versus future uncertainty.

CONCLUSION

Viability for built-in adaptability cannot be stated in general, but requires an examination of each situation. However, some general conclusions from the author's studies on designed-in/built-in adaptability are:

- Building in adaptability/flexibility involves some extra initial cost and disbenefit, which can be minimised through good design and engineering. However, this may deter those who want cheapest initial cost.
- Building in adaptability is most attractive where adaptation is anticipated in the shorter term. The attractiveness of longer-term adaptation will depend on rates used and any initial cost and disbenefit. For public sector housing, using environmental/social discounting will make longer term adaptation viable.

- Built-in adaptability will be more viable for the public sector than the private sector because of the lower rates and intangibles (social and environmental) used in feasibility studies.
- Social and environmental issues add to the value of building in adaptability, over pure financial arguments. In coming years, people may value social and environmental issues more, thus further enhancing the case for built-in adaptability.
- The 'ingenuity' of designers and engineers can overcome hurdles where there is no forethought to adaptability.
- The main arguments in favour of building in adaptability may be aesthetics and function.

Future research. The analysis given in this paper can be applied to any infrastructure – low or high rise buildings or civil infrastructure.

REFERENCES

Arge, K. (2005), Adaptable Office Buildings: Theory and Practice, *Facilities,* 23, 3/4, 119-127.

Carmichael, D. G. (2006), *Project Planning, and Control*, Taylor & Francis, London.

Carmichael, D. G. (2013), *Problem Solving for Engineers,* CRC Press, Taylor & Francis, London.

Carmichael, D. G. (2014), *Infrastructure Investment - An Engineering Perspective,* CRC Press, Taylor & Francis, London.

Carmichael, D. G. (2015), Incorporating Resilience through Adaptability and Flexibility, *Civil Engineering and Environmental Systems,* Vol. 32, No. 1-2, pp. 31-43.

Carmichael, D. G. (2016a), A Cash Flow View of Real Options, *The Engineering Economist*, Vol. 61, No. 4, pp. 265-288.

Carmichael, D. G. (2016b), Risk – A Commentary, *Civil Engineering and Environmental Systems,* Vol. 33, No. 3, pp. 177-198.

Carmichael, D. G. (2018), Estimating the Value of Built-in Flexibility in Infrastructure, *ASCE Construction Research Congress,* New Orleans, Louisiana, April 2-5, 2018, pp. 613-622, ASCE, New York.

Carmichael, D. G. and Balatbat, M. C. A. (2008), Probabilistic DCF Analysis and Capital Budgeting and Investment - A Survey, *The Engineering Economist,* 53, 1, 84-102.

Carmichael, D. G., Hersh, A. M. and Parasu, P. (2011), Real Options Estimate Using Probabilistic Present Worth Analysis, *The Engineering Economist,* 56, 4, 295–320.

Carmichael, D. G. and Taheriattar, R. (2018), Valuing Deliberate Built-in Flexibility in Houses – Exampled, *International Journal of Strategic Property Management*, to appear.

de Neufville, R. and Scholtes, S. (2011), *Flexibility in Engineering Design*, MIT Press, Cambridge.

Gann, D. M. and Barlow, J. (1996), Flexibility in Building Use: the Technical Feasibility of Converting Redundant Offices into Flats, *Construction Management and Economics,* 14, 1, 55-66.

Gilchrist, A. and Allouche, E. N. (2005), Quantification of Social Costs associated with Construction Projects: State-of-the-art Review, *Tunnelling and Underground Space Technology,* 20, 1, 89-104.

Gosling, J., Sassi, P., Naim, M. and Lark, R. (2013), Adaptable Buildings: A Systems Approach, *Sustainable Cities and Society,* 7, 44-51.

Greden, L. V. (2005), *Flexibility in Building Design: a Real Options Approach and Valuation Methodology to Address Risk*, PhD thesis, Massachusetts Institute of Technology, Cambridge.

Guma, A. C. (2008), *A Real Options Analysis of a Vertically Expandable Real Estate Development*, Masters thesis, Massachusetts Institute of Technology, Cambridge.

Heath, T. (2001), Adaptive Reuse of Offices for Residential Use, *Cities*, 18, 3, 173-184.

Karol, E. (2007), Inclusive Design and the New Home Market: The West Australian Situation, *Architectural Science Review*, 51, 1, 80-83.

Kendall, S. (1999), Open Building: An Approach to Sustainable Architecture, *Journal of Urban Technology*, 6, 3, 1-16.

Langston, C., Wong, F. K. W., Hui, E. C. M. and Shen, L. Y. (2008), Strategic Assessment of Building Adaptive Reuse Opportunities in Hong Kong, *Building and Environment*, 43, 10, 1709-1718.

Langston, C., Yung, E. H.-K. and Chan, E. H.-W. (2013), The Application of ARP Modelling to Adaptive Reuse Projects in Hong Kong, *Habitat International*, 40, 233-243.

Moffatt, S. and Russell, P. (2001), *Assessing the Adaptability of Buildings, IEA Annex 31: Energy-Related Environmental Impact of Buildings*, Canada Mortgage and Housing Corporation, Ottawa.

NCSU (2013), *Universal Design: Housing for the Lifespan of all People*, Centre for Universal Design, North Carolina State University, Raleigh, North Carolina.

Palmer, J. and Ward, S. (2013), *Housing of the Future: The Liveable and Adaptable House*, http://www.yourhome.gov.au/housing/livable-and-adaptable-house [Accessed 20 May 2015].

Schneider, T. and Till, J. (2005), Flexible Housing Opportunities and Limits, *Theory*, 9, 2, 157-166.

Slaughter, E. S. (2001), Design Strategies to Increase Building Flexibility, *Building Research and Information*, 29, 3, 208-217.

Till, J. and Schneider, T. (2005), Flexible Housing the Means to the End, *Theory*, 9, 3, 287-296.

Wilkinson, S. J., James, K. and Reed, R. (2009), Using Building Adaptation to Deliver Sustainability in Australia, *Structural Survey*, 27, 1, 46-61.

Zhang, N. (2010), *Applying Option thinking in Long Term Infrastructure Investment: The Case of Commercial Real Estate*, Masters thesis, Massachusetts Institute of Technology, Cambridge.

TECHNICAL REVIEW OF THE CURRENT EARTHWORK SMART TECHNOLOGIES IN AUSTRALIA

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Abstract
The construction industry has significant impact on the Australian economy. Digitizing the construction industry lead to produce a solid economic growth. Earthmoving tasks constitute large portion of the construction projects. Improving the performance and efficiency of the earthmoving operations has significant impact on increasing the productivity of the projects and delivers successful projects. Australia is one of the countries that are trying to follow the race toward automating the construction industry and earthmoving tasks. However, there is not sufficient quantitative research or studies showing the employment of these technologies in Australia. Knowing such information will provide database to evaluate the current and future performance of construction industry. This research investigates current situation of the earthmoving technologies in Australia, as well as the current dominant technologies for excavation construction sites. All these data are collected by performing field investigations in current construction sites that perform earthwork operations. The result showed that the Australian earthmoving industry is lagging-behind with 82% of the Australian construction industries do not use the advanced systems in their earthmoving operations, while 18% are utilising smart GPS technology and 6% are using integrated laser based and GPS technologies with their construction projects.

Keywords: Earthmoving Engineering; Construction Industry; Machine Control System; Laser levelling technology; Global Positioning System.

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BACKGROUND AND INTRODUCTION

Construction industry in Australia constitutes the second major contributor to the Australian economy as it counts for 8% of Australian Gross Domestic Product (GDP) (Hughes and Thorpe, 2014). Introducing smart systems and technologies to digitize the construction industry is the main factor to increase its productivity (Balaguer and Abderrahim, 2008). Earthwork tasks are fundamental operations in any construction project and it is generally implemented in large scale and repetitive patterns (ANZSIC, 2006). Nowadays, there is a need for automated earthmoving machines due to safety, management control, quality and productivity requirements to connect them with the digitized environment (Romed & David, 2014).

The pace of automated construction is increasing rapidly especially after the deployment of Building Information Modelling (BIM) to automate the construction industry and produce lean projects (Azhar, 2011). Currently the earthmoving engineering is considered the most advanced area among the construction industry areas (Navon, 2005). Machine control system, position tracking system, weighing and monitoring system, distance measuring system, real time display and communication system, laser based technology and GPS based technology are the current available advanced systems (Azar, 2015).

Construction industry in Australia addresses the importance of digitization to increase the productivity and economic benefits to Australia (Leviäkangas et al., 2017; Moon et al. 2016a). The current available research investigates the situation of digitization within the construction industry in general without considering that construction industry has different sub-division involves different engineering aspects (Leviäkangas et al., 2017; Moon et al. 2016b). Investigate the digitization and the technology performance within each construction sector produces comprehensive and accurate overview of the construction industry performance (Moon et al. 2015). Earthwork construction industry in Australia constitute large portion of construction projects with many advanced systems and technologies available (ANZSIC, 2006). However, there is not sufficient reports and numerical statistics showing the extent and the amount of utilising the available smart technologies within Australian earthmoving companies (Ahmed et al., 2017).

This research investigates the current earthmoving smart technologies available in Australia, and to what extent these technologies are adopted on construction sites. Having a proper numerical understanding of the status of digitization within the earthmoving operations predicts the productivity performance of the construction industry in the future. Then based on the findings data, professional actions are proposed to engage the smart technologies with the Australian earthworks machines to enhance the performance of construction industry in Australia.

Field investigations for more than ten construction sites are carried out to find out the current utilised smart technologies in the earthmoving operations within Australian construction projects.

RESEARCH METHODOLOGY

This research investigates the real usage and existence of advanced earthmoving technologies such as (machine control system, position tracking system, weighing and monitoring system, real time display and communication system, laser based technology and GPS based technology) within the construction sites of Australia. Data collection is done through field investigations to check the technologies adopted in practice. The field investigations are implemented for more than ten construction sites to explore the smart technologies adopted within the earthmoving tasks of construction sites in Australia. The

field investigation is to have a quantitative data about how many companies are following the smart systems inventions in Australia, and to check how these technologies are used within the construction industry. The quantitative data describes the performance of the construction industry in the future. Hence, strategy and corrective actions is taken to introduce the advanced technologies to the companies and business leaders to develop the construction industry in Australia.

The construction sites were selected on the basics of having active earthworks at the time of visit. The field investigations were encountered with many challenges, the main challenge was getting the approval to get to the sites to collect the required data regarding the earthmoving technologies from the site manager or site engineer, several approvals were given to enter the sites to collect the information or stay outside the site within the safety zone and speak with the project manager. The same questions were asked in every construction site to unite the data type and information collected for the research, the questions are:

- What is the project type?
- What excavators are you using on site?
- What technology are you using with the excavators and other earthmoving machines? How is it worked?
- Do you prefer any other technology? Why?

The first proposed question is to categorize the projects whether residential, non-residential, infrastructure etc. The categorization is to check the performance for every sector of the construction projects to identify the lagging and advanced area. The second question is to check whether the excavators are manually operated, semi-automated, fully automated, and to check whether the earthworks companies are interested in upgrading their earthmoving equipment or no. The third question is to observe the technology adopted in implementing the construction project whether advanced technology such as GPS based system or conventional laser system. And to investigate how these technologies are implemented within the construction project. The last question is to have an overview of the future performance of these companies and projects, whether they are considering upgrade their systems or not, and why?

After collecting all the data required from the field investigations, data analysis was conducted to observe the most dominant technology within Australia earthworks industry, then a discussion, conclusion and future works recommendations are mentioned in the end of the research based on the findings data.

RESEARCH FIELD INVESTIGATIONS

This section is dedicated to describing the field investigations to quantify the level of utilisation of state-of-the-art technologies in earthmoving process. Eleven construction sites were investigated to collect the information about the earthmoving technologies adopted within each construction site. The investigated construction sites are categorized as low-rise residential projects, mid-rise residential projects, and infrastructure projects.

Low-rise Residential Projects

(1) DEVCO project at Kew, Vic

This construction project is in Kew, VIC. The project is a four floors apartments' building. The construction site utilised basic laser levelling technology to perform the earthwork tasks. Two laser levelling apparatus are utilised in the site refer to Figure 1, the laser devices are benched to a known benchmark provided by the surveyors.

Figure 1: Basic laser levelling device.

The site has two excavators ten tonne Case CX80C and Kobelco Sk120, the excavators are manually controlled by the operators to dig the jobsite and achieve the desired depth written on the survey pegs. The excavator's operator is accompanied with a worker stands with a laser receiver mounted on a ruler to regularly observe the excavated depth and verbally communicate with the operator of the excavator whether to dig more or not. The foreman said: in the excavation work the person holds the laser receiver is considered "the boss of the work" as he controls the digging operation. The project foreman said there is no need to use smart systems and technologies such as GPS technology in the current site as it is an expensive technology, he also claimed that the manual operation and the brains of the workers are the key leaders to implement the earthworks works.

(2) Aspekt Club Apartment Project

Hawthorn Club apartments located in Hawthorn. The project is a low- rise five floors building with three basement levels. The earthwork tasks are guided by the survey pegs during the excavation process. The site was utilised Topcon laser levelling device with laser receiver mounted on a ruler and carried by a worker to regularly check the excavated depth. The site has three excavators on site: Volvo EC240B (24 tonnes), HYUNDAI (22 tonnes) and YANMAR (10 tonnes). The excavators are manually operated and controlled by the operators and they do not have any smart system. Figure 5 shows the Volvo and the HYUNDAI excavators while working to remove the excavated soil from site to the dumping truck.

Figure 2: The Volvo EC240B and HYUNDAI excavators in working process.

(3) Power Avenue Apartments

The project is low-rise residential four levels building with basement level located in Hawthorn. The excavation was undertaken by two excavators 12 tonnes CASE CX145 and CASE five tonnes. The excavation works is performed with the basic laser method by using Topcon laser levelling device with the laser receiver mounted on a ruler, the site

is marked with stakes mentioned the require depth for every position, then the excavator's operator dig accordingly with the help of the person with the laser receiver to dig to the desired depth.

(4) NOBA Apartments

The project is low-rise a residential five level building with two basement levels in Balwyn North. Three excavators were used in the site big 23 tonnes, 14 tonnes and 13 tonnes. The work on site is done by labour with no high-tech equipment or systems. For the excavation works, two Trimble laser levelling devices are used, the laser transmitter is mounted on a tripod and located on known positions as shown in figure 3 and the laser receiver is mounted on a pole and hold by a worker who regularly check the excavated depth.

Figure 3: Trimble laser levelling device.

(5) Burke Apartments

Low-rise residential project comprises of four levels and a basement in Kew. The technology adopted for this construction project is basic laser technology with Komatsu 20 tonnes excavator. Trimble laser transmitter is used with laser receiver mounted on a pole to regularly check the excavated depth. Figure 4 shows the Komatsu excavator excavating the site, the operator has full manual control of the excavator, no smart systems or high-tech specification is used with the excavator.

Figure 4: The Komatsu excavator digs the construction site.

(6) Westbourne Project

The project is sports and aquatic centre within existed Westbourne grammar school in Truganina. The construction site utilised two excavators and the basic Topcon laser levelling device with laser detector mounted on a pole. The laser levelling located on a known elevation (marked by the surveyor earlier). The excavator used is old with no smart system, display, monitoring system or sensors are included in it as shown in Figure 5 where the excavator is digging the site, and it is manually controlled and operated by the operator.

Figure 5: The excavator performs earthmoving operation.

Mid-rise Residential Projects

(1) Alexandra Luxury Apartments

The construction project is in Kew. The project is a mid-rise seven floors building with two basements levels. The site was using three excavators Komatsu 20 tonne, 13 tonnes and Case MTS 5 tonne to perform the earthwork tasks. The site engineer said, “the excavators are very old” and no smart systems are used. The excavation is done by using Trimble laser levelling with laser receiver mounted on a pole.

(2) Derby Place, Kew

The construction project is in Kew. The project is a mid- rise six floor building with three basements levels. The jobsite floor was marked with survey sticks showed the required depth for every position around the site to guide the project team. The earthworks are implemented by using three excavators CAT 330BL 35 tonne, Komatsu PC136US and C120 excavators. Figure 6 shows the Komatsu PC136US excavator performing excavating works.

Figure 6: Komatsu PC136US digs according to the survey pegs.

The project manager said that these excavators are very old nearly 20 years old each. Determination the desired depth is done by using basic laser levelling devices with laser sensor mounted on a pole. The site manager said, “Australia is behind time regarding adopting smart systems for the earthmoving works”, he said there is no need to buy expensive GPS systems or any other smart system as performing the works is feasible by using simple laser technology and labour.

(3) GlenVill Yarra Bend

YarraBend suburb locates in Alphington, Vic. The project comprises of different mid-rise buildings, houses, services and more. The jobsite was large with more than ten excavators working at the same time in different places on the site to dig trenches, lay pipes at different depths and to dig for the foundations. All the excavators are working with Trimble laser rotating technology. Firstly: the survey team place the survey pegs in

different locations on site to guide the digging operation in every position as shown in Figure 7 where the survey stakes are shown and the excavator is digging for the pipes.

Figure 7: CAT 349D in the working position along with the survey pegs.

The survey work is implemented by using Trimble total station. The operator manually guides the machine to dig to the desired depth, another person stands near the excavated area holds the laser receiver on a pole and constantly measure and check the excavated depth as shown in Figure 8 where the worker stands a head of the excavator to measure and guide the bucket digging depth, the excavators were not equipped with any monitoring and weighting systems. The project manager was not interested in using GPS technology for the earthmoving machines due to accuracy problems.

Figure 8: CITADEL excavator digs trench.

Infrastructure Projects

(1) Grange Road Level Crossing

The project is in Grange road level crossing, Alphington VIC. Photos were not allowed at this site. The project is removing the level crossing of grange road and lowering the rail way line under grange road. The excavation works is digging down for six meters for one Kilometre long. The current earthwork tasks are off-line the train line to excavate a trench for the combine services route (CSR) that comprises of all the electrical cables, single cables and all other services that supply power to power to trains and substations

The current works require three excavators on site Hitachi 225US LC 20 tonne, Komatsu pc138US-8 15 tonne and Volvo 18 tonne excavators with 3D machine control system that utilised GPS technology. The excavators are using GPS technology for excavation works. All the data is appeared on the machine display system to guide the operator when digging down the trench, the machine system shows the current and the design site models and gives detailed real-time information about the excavation works.

The machine has the current information for the drainage and under-ground services and can perform many of the works with minor assistance from the operator.

(2) Darebin Yarra Trail link

Darebin Yarra Trail link located in Alphington, Kew East. The project is constructing a shared path link from sparks reserve, Ivanhoe to main Yarra trail, Kew East. The length of the concrete trail is 1.8 km with 3 m wide, and three bridges over the Darebin creek.

The project utilised basic laser technology for excavating and determining the desired depth. The survey team put survey stakes along the project site that have the required depth to guide the operation. The site utilised Topcon laser levelling, grader Volvo 710B, three excavators 20 tonne excavator CAT ZX200, medium excavator 13 tonne CAT 312 and small excavator 5 tonne excavator CAT305D. Figure 9 shows the small excavator while performing some detail excavation for the side way of the trail.

Figure 9: The CAT305D performs detail excavations on site.

CONCLUSION AND FUTURE WORKS

This research is conducted to have a quantitative overview for the state of technologies and smart systems adopted within the Australian earthmoving industry. Having a specific data about the performance of the industry predicts the productivity in the future, hence the economic values added by the construction industry to the Australian economy. Strategies can be implemented to support and enhance the production and performance of the earthmoving industry in Australia. There are many new smart systems and technologies which can be categorized into two main streamlines: laser based technology and GPS based technology.

The current smart systems and technologies in Australia are produced from the big manufacturers companies such as Trimble, Topcon, Caterpillar and more. The concept and main objectives of the proposed systems are the same with minor differentials that are not easily recognized. The main aim of these systems is digitizing the earthworks tasks from loading, navigating and dumping process to reduce the reliance on the machine's operator and increase the productivity. The smart systems and technologies focus on enabling automatic loading process, enable professional and/or automatic navigation and localization systems on site, enable the operator to have full real-time data about the piles and environment surrounding the earthmoving machines, and modelling the environment and machine in a virtual representation appears in the control box of the machine.

To accomplish the research objectives, data was gathered through field investigations to observe the technologies and smart systems adopted within the construction industry. Data was collected from eleven construction sites projects. The results from the field investigations showed that 82% of the projects use the basic levelling systems while 18%

of the projects used GPS technology on sites to perform the earthmoving tasks. To summarize the results 82% of the data collected adopted the basic laser technology, 18% of the data collected adopted advanced GPS technology and 6% are using both GPS and laser technology. Some of the companies equipped the earthmoving machines with systems such as back camera and bucket scale. The usage of the technologies mainly depends on the size of the company and the earthmoving tasks. The large companies which mainly take large infrastructure projects such as tunnel and mines adopt smart technologies for the earthmoving machines, while the mid and small size companies are mainly using the basic laser technologies and methods to implement the earthworks tasks. The mid and small companies are not showing realistic and serious intention to upgrade their methods and systems.

Many research, case studies, conference and training programmes should be held to change the mind set (acceptance) and educate the workers who directly involved in the construction process about the real benefits of these systems.

More research and survey is recommended to support this research, it is recommended to have individual research to cover GPS technology and/or laser technology in detail and investigate its impact on the earthmoving tasks. This research did not cover the mass infrastructure projects such as mines, dams and tunnels due to lack of time and the long and complicated procedure that are required to get the approvals to obtain these information form these high-risk environment, therefore, it is recommended to have detailed individual research about these projects and the technologies adopted to implement their operations.

REFERENCES

AHMED, N., HONG, A. J., KU, H., MOON, S. & MOON, S. Technical Review of Automated System Application to Earthworks in Australia. ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction, 2017. Vilnius Gediminas Technical University, Department of Construction Economics & Property.

AKE, D. K. 2001. Laser receiver and angle sensor mounted on an excavator. Google Patents.

ALSHAER, B., DARABSEH, T. & ALHANOUTI, M. 2013. Path planning, modeling and simulation of an autonomous articulated heavy construction machine performing a loading cycle. Applied Mathematical Modelling, 37, 5315-5325.

ANWAR, H., ABBAS, S. M., MUHAMMAD, A. & BERNS, K. 2014. Volumetric estimation of contained soil using 3d sensors. Commercial Vehicle Technology, 11-13.

AZAR, E. R., AGNEW, G. & PARKER, A. 2015. Effectiveness of automated machine guidence technology in productivity improvement: case study.

AZHAR, S. 2011. Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. Leadership and management in engineering, 11, 241-252.

BALAGUER, C. & ABDERRAHIM, M. 2008. Trends in robotics and automation in construction. Robotics and Automation in Construction. InTech.

BRABEC, V. J., CRUMB, B. B. & GRAHAM, R. T. 1999. Bucket depth and angle controller for excavator. Google Patents.

CARPENTER, H. J., PIEKUTOWSKI, R. P. & NICHOLS, M. 2014. Method and system for controlling an excavator. Google Patents.

FILLA, R., OBERMAYR, M. & FRANK, B. A study to compare trajectory generation algorithms for automatic bucket filling in wheel loaders. 3rd Commercial Vehicle Technology Symposium, 2014. 588-605.

HEMAMI, A. 1995. Fundamental analysis of automatic excavation. Journal of Aerospace Engineering, 8, 175-179.

HUGHES, R. & THORPE, D. 2014. A review of enabling factors in construction industry productivity in an Australian environment. Construction Innovation, 14, 210-228.

JONASSON, S., DUNSTON, P. S., AHMED, K. & HAMILTON, J. 2002. Factors in productivity and unit cost for advanced machine guidance. Journal of construction engineering and management, 128, 367-374.

KIM, S.-K., SEO, J. & RUSSELL, J. S. 2012. Intelligent navigation strategies for an automated earthwork system. Automation in Construction, 21, 132-147.

LEVIÄKANGAS, P., PAIK, S. M. & MOON, S. 2017. Keeping up with the pace of digitization: The case of the Australian construction industry. Technology in Society, 50, 33-43.

NAVON, R. 2005. Automated project performance control of construction projects. Automation in construction, 14, 467-476.

MOON, S., ZEKAVAT, P. R., & BERNOLD, L. E. (2015). Dynamic control of construction supply chain to improve labor performance. Journal of Construction Engineering and Management, 141(6), 05015002.

MOON, S., FORLANI, J., WANG, X., & TAM, V. (2016a). Productivity study of the scaffolding operations in liquefied natural gas plant construction: Ichthys project in Darwin, Northern Territory, Australia. Journal of Professional Issues in Engineering Education and Practice, 142(4), 04016008.

MOON, S., ZEKAVAT, P. R., & BERNOLD, L. E. (2016b). Dynamic quality control of process resource to improve concrete supply chain. Journal of Construction Engineering and Management, 143(5), 04016130.

Romed Kelp & David Kaufmann 2014. Construction Machines in the digital age, Oliver Wyman. available at http://www.oliverwyman.com/our expertise/insights/2017/jun/construction-machines-in-the-digital-age.html.

ANZSIC 2006. Australian and New Zealand Standard Industrial Classification, Australian Bureau of Statistics, STATISTICS NEW ZEALAND. Available at http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/19C21C5659BCAE73CA2574C8001474E4/$File/12920_2006.pdf

DEVELOPING A MODEL FOR MELBOURNE PROPERTY ASSESSMENT

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Abstract
A proliferation of desktop valuation tools have emerged in recent years to provide property valuation for public in major cities across the world including Melbourne. However, there are variations in prices estimated or predicted by these online tools because of their difference in models and methods adapted to estimate makes them unreliable. These tools use automated valuation models (AVM's) to determine the value for the property depending on the current market trends and fails to provide true value of the property. Considering that, this research endeavours to develop a new model for desktop valuation to estimate the true value of residential properties for Melbourne suburbs and also, to predict the property values for the same in any given year. Therefore, it is crucial to study how the existing models are developed to understand and analyse the framework and their work function. This study helps to conceptualise new method, aiming for the quality indexes to develop a model for evaluating true value of the properties. In this research the working of the proposed new model is shown and conclusions are drawn. In future, the applications of new model are analysed for further improvement and conclusions on the working efficiency of the model is drawn by estimating price for selected properties in different years across multiple suburbs of Melbourne.

Keywords: Property Valuation; Automated Valuation Models (AVMs); Land and structure price; Growth Percentage.

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BACKGROUND AND INTRODUCTION

Property valuation is a process of determining a monetary estimate of a property's value for given market conditions (Khedkar, Bonissone et al. 2003; Moon et al. 2010). Over the past decades, property valuation has evolved from simple mathematical judgments to automated valuation models and their applications have extended from single property valuations to mass valuations (Clapp 2003). Traditionally, real estate personnel performed appraisals manually, which are subjective and vary depending on the appraiser (Glenn and Yee 2006). The process is slow, expensive and prone to error, thus the need to automate the valuation process (Khedkar, Bonissone et al. 2003). "AVM stands for Automated Valuation Model". It is a computerized model designed to value properties (Waller, Riley et al. 2001). The computer program, based on information such as demographics, property characteristics, sale prices and price trends produces an indicative value of a property (Faishal Ibrahim, Jam Cheng et al. 2005).

"The interest in developing techniques for automated valuation methodologies (AVM) is increasing, because of their wider applications in property taxation, insurance real estate investment trusts (REITs) and mortgage management" (d'Amato 2007). The main purpose for development of AVM's is to conduct mass appraisals of properties for any given locality (Flaherty 2004). In Australia it appears there is increasing pressure from banks and financiers to integrate AVMs into the mortgage assessment process (Fortelny and Reed 2005). AVMs increased the accuracy of mass appraisals while reducing their cost (Pace, Sirmans et al. 2002). They have faster turnaround and are available for direct end user (Mooya 2011). Additionally, the characteristics of being consistent and non-biasness nature made them preferable over traditional appraisers (Faishal Ibrahim, Jam Cheng et al. 2005).

The models are developed on the basic methods they used to follow in estimating value similar to that of traditional approaches (Pace, Sirmans et al. 2002; Moon and Bernold 2013). The one major difference is that the estimate of value generated from an AVM may be based on hundreds, or possibly thousands, of previous sales which enhances the underlying validity of the valuation (Waller, Riley et al. 2001). AVMs are like many programs used to predict the future they extrapolate relationships that existed in the past, and assume they will be continued in the future (Waller, Riley et al. 2001). However, because conditions for providing valuations and the quality of computer programming are not always equal different automated valuation models have many and varying degrees of accuracy (Cagan 2006).

Although property valuation models have become an important paradigm in real estate market research, the results of the most well-known approaches are limited due to various data-related problems such as the non-linearity of relationships, the presence of noise, or the absence of necessary information (García, Gámez et al. 2008). In addition to the property's intrinsic value, derived from its location, size, construction, views, etc., demand and supply conditions prevailing at a point in time influences market price and hence value (Flaherty 2004).

AVMs in real estate appraisal require stable market conditions as they work in marketable timeframe (Waller, Riley et al. 2001). AVMs are unable to capture the changing conditions in the market and trend of data (Glenn and Yee 2006). Any estimate must be periodically updated to reflect those market changes and needs to be supported by current evidence of market conditions, e.g. recent real estate transactions (Bonissone and Cheetham 1997). AVMs depend on the accuracy, comprehensiveness and timeliness of the data they use (Valentine 1999). Appraisal process does not provide much insight on how the comparable properties were selected, how the adjustment rates were

determined, or most importantly how credible the analysis has been, all of which often results in estimates that do not support expected outcomes (Robbins 2001).

RESEARCH METHODOLOGY

The main purpose of this research is to develop a model for the assessment of property in Melbourne and its suburbs. Since, the model is dependent on the mathematical and statistical data the quantitative research approach is adapted to collect the data, develop the model, application of model, testing and validating the model. The model will be developed using known variables, established guidelines and predetermined methods. The collected data will be numeric and from the validated statistical sources. Standard instruments are used for analysis, mathematical calculations and validation. The following research framework is applied for this research.

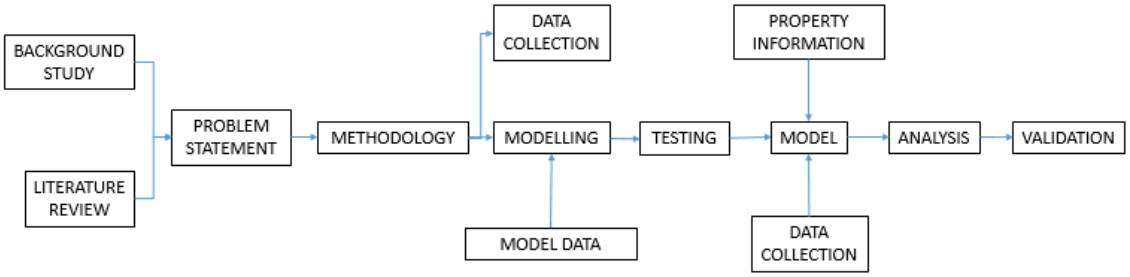

Figure 1: Research Framework.

The model needs to be developed which consists of the logic on which the model works. Then, data that needs to be collected for the function of the frame work is to be identified. Methods needs to be selected according to the types of data and implement those methods. Then, the working of the model needs to be tested by supplying the information of the subject property. Then model needs to process the information supplied of the subject property and data collected. The results needs to be analysed and validated to understand the efficiency of the model and to draw the conclusions.

The frame work of the model is similar to that of the expert's model but the method of logic developed is different. The model requires three sets of data of which two of them which are land costs per square units in each suburbs and the rental costs per bedroom sizes in each suburbs that can be obtained directly from the established sources like (Services 2017) and Real Estate Institute of Victoria. The third set of data is collected from the established builders in Melbourne to understand the construction costs per SQ.M depending on the quality of construction for both single and double storey. The data collection also includes percentage increase in construction costs per annum. And average life span of the houses depending on the quality of structure and other relevant information like when it comes to increase in lifespan after major renovation and added value after renovation etc.

MODELLING

It is understood from the literature review that all the existing models for the current AVM's are designed based on direct comparison, hedonic models or hybrid models. It is also understood that the values cannot be reliable and are complex with innumerable variables to consider. This lead to the development of new approach for the valuation, which is cost oriented approach by breaking down the property into land and structure components. In order to get sensible results the model uses percentage of growth in cost for land, cost of construction for structure individually.

Since the residential property in Melbourne is mostly the combination of land and house, the value of property is equal to the sum of Value of land and value of land and value of structure.

Vp = Vl + Vs
Vp = Value of property
Vl = Value of land
Vs = Value of structure

The model is divided into two parts. First one to calculate the value of land. The Variables to include to predict/calculate the value of land are:

- Year of prediction.
- Price of land per SQ.M in the specified suburb
- Percentage increase in land rates per annum
- Land area.

A simple tabular model is developed with the columns to input the data and select the relevant existing data. To generate the land value of any given suburb.

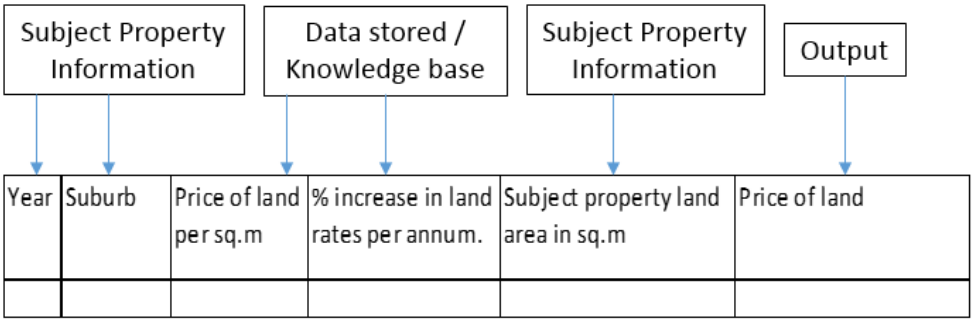

Figure 2: Tabular Model framework to estimate value of land.

When the suburb location is selected, the current price of land in that suburb is automatically identified along with the percentage increase in the land price per annum. Depending up on the year selected the suburb price in that year is calculated using the percentage change in each year and the current value. Now, by adding the size of land the final value of land is generated by multiplying between the plot size and the calculated price of land in the given year.

The value of the land is determined when the subject property information about the suburb, land area and year to be estimated is given. With the available land values from the year of 2001 the % growth of property value for every year is determined and the three variables price of land, percentage and areas are multiplied to get final price of land for any given year.

The variables that include to predict/calculate the value of structure are:

- Year of built
- Single / Double storey
- Quality of Built (High/Medium/standard)
- Cost of construction in that year of built
- Built area
- Life span of the structure (High-40, Medium-35, Standard-30)
- Depreciation percentage

- Liveable condition life span
- Rental rates in the area depending on the bedrooms
- Percentage increase in rentals per annum
- Value to add after major renovations (If Applicable)

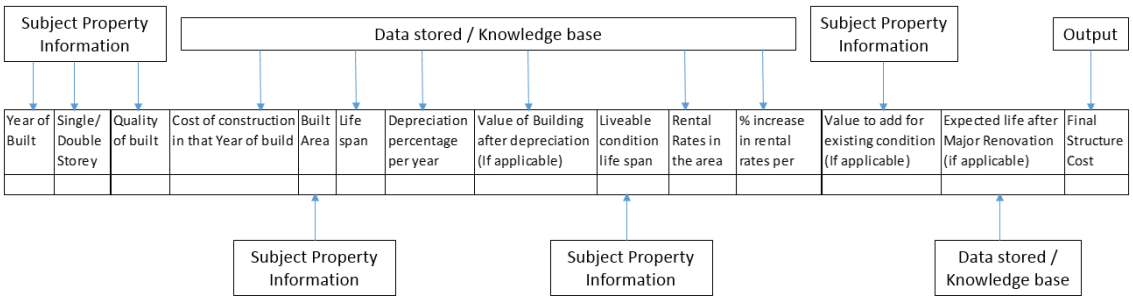

Figure 3: Tabular Model framework for structure estimation

The second part of the model is the calculation of the structure and after the land value is calculated, the year of built of structure is supplied to the model along with the factors mentioned above. From the data collected from the practising builders of Melbourne the current cost of construction is collected and the price of different types of standards in construction is noted depending on the quality of construction. Also the prices for different single and double storey are collected to calculate the value of the residence across time.

Value of the structure is determined by hedonic regressions in the housing context. The data required for the construction related cost is obtained first hand from the practising builders in Melbourne through surveys and interviews. With the help of predetermined values for the building costs and land costs per SQ.M and percentage of increase and depreciation in the costs are estimated to find the true value of the property. In case the structure is renovated the life time of the property is increased to two thirds of its original life. If the property is still liveable after the life span of the building, then the approximate liveable life time is calculated and the structure is valued according to the rental values of the property in that suburb.

Now the total value of the property is calculated by adding the sum of price of the land and price of the structure.

TESTING

Any model needs to be empirically tested to know its ability to predict consistently enough for its continuous use is required for the validation of the project. Preliminary testing is conducted using a couple of properties one both in East and West of Melbourne, making the properties of both land and structure very different. The first property to test the model is in Williams landing to find the true value of the property using the model. The information about the property is as follows:

Suburb: Williams Landing
Year of to be estimated: 2017
Area of the land: 460SQ.M
Built area of the property: 250 SQ.M
Year of Construction: 2014
Storey: Single
Quality of Built: Standard

With the above mentioned minimum data the value of the property is determined using the developed model. First, the value of land is estimated and then the value of the structure is estimated.

Year	Suburb	Price of land per SQ.M in given year	% increase in land rates per annum.	Land Area in SQ.M	Price of land
2017	Williams Landing	$1506	6%	460	$692,760

Table 1: Calculating value of the land for property 1

Year of Built	Single/ Double Storey	Quality of built	Cost of construction in that Year of build	Built Area	Life span	Depreciation percentage per year	Value of Building after depreciation (If applicable)	Liveable condition life span	Final Structure Cost
2014	Single	Standard	$941	250	30 years	3.3	$211725	27 Years	$211725

Table 2: Calculating cost of structure for property 1

Now the total cost of the property is estimated as sum of the price of land and Final structure cost which is equal to $904485 in this case. Since, the building is new other factors are not considered.

Now, the second property that is tested is located in Box hill to find the true value of the property and also the estimate of the property in for 2020.

The information about the property is as follows:

Suburb: Box Hill

Year of to be estimated: 2017 and 2020

Area of the land: 647SQ.M

Built area of the property: 160 SQ.M

Year of Construction: 1982

Storey: Single

Quality of Built: Medium

Year	Suburb	Price of land per SQ.M in given year	% increase in land rates per annum.	Land Area in SQ.M	Price of land
2017	Box Hill	$3248	3.26%	647	$2,101,456

Table 3: Cost of land for property 2 for the year 2017

Year of Built	Single/ Double Storey	Quality of built	Cost of construction in that Year of build	Built Area	Life span	Depreciation percentage per year	Value of Building after depreciation (If applicable)	Liveable condition life span	Final Structure Cost
1982	Single	Medium	641	160	35 years	2.85	0	6	$393

Table 4: Cost of structure for property 2 for the year 2017

The total value of the property is estimated as sum of the land and structure values which is equal to $2,222,683.

Now to estimate the value of the property 2 in 2020, the calculations are done again. With the change in the year.

Year	Suburb	Price of land per SQ.M in current year	% increase in land rates per annum.	Land Area in SQ.M	Price of land
2020	Box Hill	$3248	3.26%	647	$2,318,378

Table 5: Cost of land for property 2 in 2020

Year of Built	Single/ Double Storey	Quality of built	Cost of construction in that Year of build	Built Area	Life span	Depreciation percentage per year	Value of Building after depreciation (If applicable)	Liveable condition life span	Final Structure Cost
1982	Single	Medium	641	160	35 years	2.85	0	3	$393

Table 6: Cost estimate of the structure for property 2 in 2020

The sum of the land and property costs gives the property worth in the year 2020 which is $2396714 which is a significant increase in the property value.

FINDINGS AND DISCUSSION

The tests shown some interesting results. The values estimated by the model are higher than the expected values and real world values. It is observed that the main difference in the values is because of the land values generated by the model. The issue could be the price of square meter which is sourced from (Victoria 2017), the values obtained from REIV needs to be verified once again to validate the credibility of the source. The other reason could be the drop in recent market trend and value. It is also observed that when the same property is valued in two different timelines the results are encouraging as the rise in the price between the two time intervals seems to be reasonable and the percentage of raise is similar to that of current market.

It is understood from the findings that the relatively complex side of the model which deals with the structure has better performance results than the part of model which deals with the land estimate. Logically land estimate is supposed to be easier to generate and produce more accurate results than the other half because of its large data set availability over the period of time. The results shown that the current model for evaluating the structure of the property looks promising. As the numbers that are generated in the valuation process are very close to the real values. The method successfully calculates even the value of the old structures. It is noticed that the implementation of the rent value model for the buildings that are totally depreciated in terms of constructed value gives promising results and works in a very practical approach without any complex models.

SUMMARY AND CONCLUSION

The working of the model is compared against the literature models and the difference is observed regarding the simplicity of the model, the comprehensibility to the common public and the ability of the index used in the model to be able to predict the prices for the future. It is understood from the findings that the part of model with the land valuation needs to be tested and analysed to find the location of the problem. The model is still in the preliminary development phase where it needs to be tested across multiple properties in different suburbs. Considering the results, the source values are needed to be cross checked with other sources. If the source of land values seem to be credible then the model needs to be improved. Model predictions need to test against real world values for complete validation. It is imperative to close the accuracy between the model estimated and the market values for the model to be used more by the public. It is too early to decide the credibility of the model as more number of properties needed to be tested in order to draw conclusions.

REFERENCES

AAO, I. (2003). "Standard on automated valuation models (AVMs)." Assessment Journal 10(4): 109-154.

Anderson, S. T. and S. E. West (2006). "Open space, residential property values, and spatial context." Regional Science and Urban Economics 36(6): 773-789.

Bonbright, J. C. (1937). "Valuation of property."

Bonissone, P. P. and W. Cheetham (1997). Financial applications of fuzzy case-based reasoning to residential property valuation. Fuzzy Systems, 1997., Proceedings of the Sixth IEEE International Conference on, IEEE.

Bradley, M. G., et al. (2003). Method for combining house price forecasts, Google Patents.

Cagan, C. (2004). Method and apparatus for spatiotemporal valuation of real estate, Google Patents.

Cagan, C. (2006). Method and apparatus for constructing a forecast standard deviation for automated valuation modeling, Google Patents.

Carbone, R., et al. (1980). "Competition used to select a computer-assisted mass appraisal system.[Electronic version]." Assessors Journal 15(3): 163-167.

Clapp, J. M. (1977). "The cost approach to market value: Theory and evidence." Assessors Journal 12(1): 43-46.

Clapp, J. M. (2003). "A semiparametric method for valuing residential locations: application to automated valuation." The Journal of Real Estate Finance and Economics 27(3): 303-320.

d'Amato, M. (2007). "Comparing rough set theory with multiple regression analysis as automated valuation methodologies." International Real Estate Review 10(2): 42-65.

Diewert, W. E., et al. (2015). "Hedonic regressions and the decomposition of a house price index into land and structure components." Econometric Reviews 34(1-2): 106-126.

Faishal Ibrahim, M., et al. (2005). "Automated valuation model: an application to the public housing resale market in Singapore." Property Management 23(5): 357-373.

Flaherty, J. (2004). Measuring and evaluating changes in returns for residential Property. Tenth Annual Pacific Rim Real Estate Society Conference, Bangkok.

Fortelny, A. and R. Reed (2005). "The increasing use of Automated Valuation Models in the Australian mortgage market." Australian Property Journal 38(6): 681-685.

García, N., et al. (2008). "ANN+ GIS: An automated system for property valuation." Neurocomputing 71(4): 733-742.

Glenn, C. and C. Yee (2006). Method for optimizing accuracy of real estate valuations using automated valuation models, Google Patents.

Gloudemans, R. J. and D. W. Miller (1976). "Multiple Regression Analysis Applied to Residential Properties." Decision Sciences 7(2): 294-304.

Graham, F. (1966). "Comparative method for mass assessment of residential real estate." Assessors Journal 1(3): 41-54.

Heikkila, E., et al. (1989). "What happened to the CBD-distance gradient?: land values in a policentric city." Environment and planning A 21(2): 221-232.

Khedkar, P. S., et al. (2003). Methods and systems for automated property valuation, Google Patents.

McCluskey, W., et al. (1997). "Interactive application of computer assisted mass appraisal and geographic information systems." Journal of Property Valuation and Investment 15(5): 448-465.

Moon, S., et al. "An analysis of Land Mark impact factors on high-rise residential buildings value assessment." International Journal of Strategic Property Management 14.2 (2010): 105-120.
Moon, S., and Leonhard E. Bernold. "Causality analysis for dynamic quality control in construction." International Journal of Engineering and Technology 5.5 (2013): 541.
Moore, J. W. (2006). "Performance comparison of automated valuation models." Journal of Property Tax Assessment and Administration 3(1): 43.
Mooya, M. (2011). "Of mice and men: Automated valuation models and the valuation profession." Urban Studies 48(11): 2265-2281.
Pace, R. K., et al. (2002). Automated valuation models. Real Estate Valuation Theory, Springer: 133-156.
Reed, R. and H. Wu (2010). "Understanding property cycles in a residential market." Property Management 28(1): 33-46.
Robbins, M. (2001). Process for automated real estate valuation, Google Patents.
Rosen, S. (1974). "Hedonic prices and implicit markets: product differentiation in pure competition." Journal of political economy 82(1): 34-55.
Rossini, P. and P. Kershaw (2006). Developing a weekly residential price index using the Sales Price Appraisal Ratio, Pacific Rim Real Estate Society.
Sennott, M. (2002). Method of establishing an insurable value estimate for a real estate property, Google Patents.
Services, D. o. H. a. H. (2017). Rental Report June Quarter 2017. H. a. H. Services. Victoria, Department of Health and Human Services.
Valentine, L. (1999). "Automated valuation models speed the appraisal process." American Bankers Association. ABA Banking Journal 91(1): 46.
Victoria, R. E. I. o. (2017). REIV Research Median Prices per sqm.
Waller, B. D., et al. (2001). "An appraisal tool for the 21st Century: Automated Valuation Models." Australian Property Journal 36(7): 636.

A FUNDAMENTAL STUDY ON THE HOUSING RISK OF A LIFE COURSE

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Abstract
This study aims to identify causes of housing risk influenced by the social change after the bubble burst economy in Japan. Housing poverty is intensifying in the background of the change of population, economy and the policy in Japan. At first, the change of population structure means the decreasing of population and the reduction of household size such as living alone and aging of population. The second is the change of industrial structure, a business structure, and an employment form accompanying with the economic globalization. The third is the change of government policy which becomes enablers from providers. The Japanese safety net for living has collapsed against the background of these factors.

The government has been developing the provisions lead the independence by working so that livelihood protection recipients may be decreasing. However, people who are trapped in a vicious circle of poverty cannot recover from a crisis.

This study involved interviews with organizations such as the support center for vulnerable people, NPOs for housing or for the homeless. And it also analyzes the data from the telephone consultation service. The survey of this study has been carried out since October 2017.

Keywords: housing risk, life course, telephone consultation, housing policy

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INTRODUCTION

Supply system of housing in Japanese society was established during the period of high economic growth, although housing issues has become clear after the collapse of bubble economy, which peaked out around 1990. The system which developed during the high economic growth period faced difficulties to function properly from the influence of changing economy and population, mismatch of housing stock and urban structure with actual residents—this situation promoted the increase of people having difficulty in finding their housings. This study identifies the shift of the environment in the supply system of housing in Japan, along with the illustration of triggering factors to develop housing difficulties by looking at the records of telephone consultation for housing issues, which cannot be handled even by the new "housing safety net system" currently under development.

System to acquire housing during the period of high economic growth

It was the "high economic growth" that strongly influenced the Japanese society after the World War II. This "high economic growth" improved the living standard of Japanese society in total. Secondary industry centralized around manufacturing industries was the drive to lead Japanese economy, although large-scale migration of population from rural towns and villages to metropolitan areas produced large issues of underpopulation and overpopulation throughout Japan. Large-scale building and scrapping of housing occurred to absorb population in metropolitan areas. In order to form an orderly urban district, new satellite towns (housing complex) were developed in the suburban district of metropolitan areas.

Mechanism of acquiring housing during the period of high economic growth was supported by three factors. The first factor is the "economy led by manufacturing industry". This structure required many laborers working in factories. As the transportation system was not fully developed then, workers needed to live close to their factories, and it was not difficult for them to find buyers of their housing property. The second factor is the "wage system based on seniority and lifetime employment system". Stable employment was guaranteed and the income increased every year, which made workers pay their housing rent or mortgage. The third factor is the "increase of land prices and housing prices". Rise of land prices beyond consumer prices made acquiring housing (including its land plot) as a safe and profitable investment. Trading of housing provided a large sum of capital gains as the consequence of increased land price, which made it easier to buy a new house for replacement.

Housing standard during the period of high economic growth improved along with the increase in wage and land prices. A course of moving up the status of housing from—a wooden structured rental housing—to a non-wooden structured rental housing—and to a detached house with a garden space in suburbia—was called as "Housing Sugoroku" (traditional Japanese variety of "The Game of Life" or "Monopoly" style board game). During this period, population moved from rural towns and village to major metropolitan areas as an effect of paradigm shift in the structure of industries. As increased population group established households, demand for housing also increased. Housing development during the period of high economic growth brought out mass production and mass demolition of housing, since housing supply dependent on the needs of housing market developed discontent with the quality of supplied housing, creating new demand for housing. Housing construction rate per 1,000 residents was at high pace, around twice the rate of America and three times that of the United Kingdom. It was under recognition that housing development produced powerful economic ripple effect, because of its broad extent of industries related with housing construction or extra purchase of durable goods

made by the residents at the time of buying housing. Policy toward housing construction (Act of housing construction planning) was developed as the instrument to maintain economic condition. Potential demand for housing was brought out at different timing from actual demand period in the life stage of people for purchasing house, by controlling interest rate or tax deduction system for acquiring houses during the period of recession. Residents gradually developed weariness and fatigue for enlarged debt of housing cost.

2. Shift of economy in Japanese society

Collapse of bubble economy as it peaked out around 1990 produced critical situation for the functionalities of various systems to support housing environment. Those changes—"shift of economy", "shift of social/ population structure", and "shift of urban structure and issues of utilizing housing stock"—made such functionalities difficult to operate. "Shift of economy" here implies the shift in the structure of industries and the form of companies, the shift of employment pattern, and decline of land price. Shift of social economy toward service industry and mergers of companies weakened the linkage between work place and housing environment necessitating proximity of those two locations, which made it difficult to utilize housing property as an asset to succeed. Globalized economy promoted inflow of low-income laborers and expansion of dispatched laborer for temporary work in metropolitan areas. This situation increased the number of laborers under the conditions of unstable, low-income jobs with difficulty to pay housing rent or mortgage. Declined land prices also made it hard to improve living standard by purchasing replacement housing. In any cases, shifted social and economic structures promoted difficulties to securely maintain stable housing environment.

"Shift of social/ population structures" implies "aging of population composition", "decreased size of a household" (increase of single household), "shift of composition in the type of disease" (increase of chronic diseases), "public recognition for people with disability", "decrease of population", "issues of divorce, domestic violence, or discord within a family". Increase of single, aging household, people with disability, divorce, domestic violence, discord within a family then indicates increase of fragile household with necessity of social assistance for housing.

"Shift of urban structure and issues of utilizing housing stock" means that urban districts, which had been expanded throughout the periods of high economic growth and bubble economy, are now turned to shrinkage in scale, and they are left behind in suburbs as inconvenient areas, or in the center of cities without getting updated. There are houses with the conditions of limited sizes or in mid-height building up to five stories without bathrooms or elevators. Such housing is difficult for elderly and disabled people to live in, while the number of those elderly and disabled people are increasing today. Furthermore, many of those houses have passed 40 to 50 years of time from their construction, generating other issues of reconstruction or compulsory relocation of elderly living in such aged buildings.

The shift of economy promoted unstable income condition, which is occurring along with the reduction of household scale. At the same time, progressed aging of population, public recognition for people with disability, increase of fragile household generated strong need of support for housing. Nevertheless, currently supplied housings, which shall become the foundation of living, are not supporting well enough for the living of people with increasing conditions in uncertainty, since those housings are insufficient in terms of their scales and functionalities. Today’s economic condition, population issue, housing issues are all promoting this situation where stable living environment is hard to achieve.

Situation of housing difficulties

Disruption of the systems for acquiring and maintaining housing. Situations of housing difficulties are outlined below.

① Insecure and reduced income condition destabilized the ability to pay for housing cost, thus housing environment became insecure among people. In addition, shift of the structure in industries and globalization made it difficult for the residents to sell their housing property.

② Growing number of elderly, single household or varying types of household promoted fragility of such households to cope with illness, injury, or disability situations. Insufficiency of financial condition (savings, etc.) to sustain living and the lack of family members to take part in nursing care owing to the shrinking scale of household lead to the of housing difficulties.

③ Elderly or disabled people are growing in number, who cannot live in houses or towns which are small and old and do not function as the foundation of living.

④ Japanese government established a new "Act for housing safety net system" upon public recognition of people facing "no income", "no guarantor", "no housing support", "no house" conditions with difficulty to secure housing environment. However, it has become clear that this system is unable to respond to actual situation such as "a household facing to housing difficulty with aging parents and middle-aged child with disability, when the parents die and the child is left behind".

In order to point out and clarify the triggering factors of housing difficulties, the records of actual consultation cases were evaluated from "Aichi prefecture's helpline for landlords who watch for residents" in 2016. Subjects of this evaluation study are those 285 cases of consultation received by the helpline from April 1, 2016 to March 31, 2017. Followings are the classified example cases with identifiable reasons of falling into the situation of housing difficulties.

① Loss of capability to pay for housing cost by unemployment or retirement

a) 67-year-old retired male, who lives in a dormitory. Amount of pension is 65,000 Yen per month.

② Reduced or loss of capability of living, of paying for housing cost by (both physical and mental) illness

a) 70-year-old male, a taxi driver living in a dormitory of the taxi company. He was hospitalized for spinal canal stenosis to receive medical operation. Then he retired from the job during his stay in hospital, and now he has no place for living anymore.

b) 57-year-old male with bipolar disorder, currently staying in a hospital. He used to live in a detached house with his parents, but he left the house when he was hospitalized. His parents then deceased.

③ Loss of living place by discord with a person living together, domestic violence from a person living together, or separation by the death of a person living together.

a) 53-year-old mother and her daughter in 20s evading from domestic violence and staying at a business hotel.

b) 39-year-old Filipino female and her 20-year-old and 9-year-old sons. Their

69-year-old Japanese husband extorts money from them. He tells them to move out if they do not pay money. Her 20-year-old son cannot stay in a supporting shelter. Her sons have Japanese nationality. Mother has difficulty in Japanese language.

c) 72-year-old female who lives in Tokyo. As her husband died, she wishes to move to Nagoya city, where her younger sister lives. However, she was told she could not sign a housing contract for her age as she is over 70 years old.

④ Evacuation or forced displacement by disasters or accidents

a) 74-year-old female. Her apartment got damage by the fire of the adjacent room, as the tatami floor of her apartment got scorched. Although there is a vacant room on the 3rd floor, she cannot move to the room for higher rent—furthermore, there is no elevator.

⑤ Forced displacement by demolition of aging building

a) 69-year-old female who is asked to move out as the building is planned to be demolished. She has a Grade 3 disability and lives on welfare. She is hospitalized for a broken bone, and she will need to go to the hospital for regular treatment in the future. The building is a tenement house with 2 units, and her neighbor has already moved out with belongings.

b) 72-year-old male who is asked to move out by real estate agent as the apartment will be dismantled to make a vacant lot for sales.

c) 5- year-old female who is asked to move out for dismantling apartment building. She has weak physical and lives on welfare.

⑥ Displacement advisory for receiving livelihood protection

a) 44-year-old female who lives in a house for the rent of 66,000 Yen. Her 16-year-old son is in juvenile reformatory. She received displacement advisory for receiving livelihood protection. She needs to find a ground floor room or single-story house as she has leg problem.

b) 67-year-old male who worked as a carpenter, but he injured his shoulder and was forced to quit working. He lives in an apartment with the rent of 65,000 Yen, but he needs to move out because the amount of his pension is 60,000 Yen.

Major triggering factors of falling into housing difficulties are “illness”, “aging”, “domestic violence or discord with family member”, “demolition of housing”, and “disaster”. Although a single factor could produce the cause of falling into housing difficulty, multiple factors are occurring simultaneously or successively in most of the cases. Such cases could be the combination of “illness” + “aging”, “demolition of housing” + “aging”, “discord with family member (and his/her death) + “aging”, “retirement” + “aging”. Those cases become visible as; the factors of “retirement”, “illness”, “death of one’s spouse” are combined with the issues of population aging; the housing difficulty for elderly residents where the issue of reconstructing aging housing stock overlaps with aging of residents. Collapse of human relations is causing the increase in the number of people losing their place for living—with those previously invisible issues of domestic violence or discord among family members. Furthermore, there is this regulatory issue of displacement advisory for receiving livelihood protection

support. In any cases, shift of social and economic conditions occurred from 1990s became the cause of housing difficulties.

CONCLUSIONS AS FOR THE SUMMARY OF THIS REPORT

Timing of the occurrence of housing difficulties cannot be predicted in advance. Housing difficulties become visible when those elements of life support such as work, family member, health conditions start failing. Each element does not stay permanently but it is difficult to specify the timing of losing it. In order to deal with such triggering factors causing housing difficulties, it is necessary to have common understanding that everyone has “the equal right of living” in proper housing, and establish this understanding as an actual right in our society. Otherwise, arrearage of housing rent or absence of guarantor and rental agreement would take precedence over the person in difficulties to cope with those problems, and they lose their living places. In order to prevent such problem from occurring, it is necessary to clearly state the “guarantee of housing” as an essential part of the social security system in Japan.

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ON THE USE OF BUILDING INFORMATION MODELLING FOR DESIGN INTEGRATED APPROACH

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Abstract
As the demands on the built environment grow, the coordination and planning of development need to increase in both its ability to deal with complexity and scalability. Building Information Modelling (in this context, we limit it to the Industry Foundation Standard- IFC) provides a set of protocols for information exchange and long-term data legibility. Among other things these protocols give a means for representing three-dimensional data, methods for separating out layers of a project and also for accounting timelines and project phasing. In this research, we highlight the importance of using building information modelling as a platform for data exchange between local council, developers and architects. The case of energy analysis in the thermal and visual environment is explored with regard to information transfer in the integrated design process. The feedback loops created by ubiquitous computing also provides an avenue for designing systems that optimize performance, minimize energy and make better use of resources.

Keywords: BIM; Design Integrated Approach; Lighting; Thermal Analysis; Ventilation

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INTRODUCTION

With the building sector consuming half of the world's energy, good design, coordinated and responsible development and construction management become ever more critical when we talk about sustainability. In the United Kingdom, housing makes up 45% of CO_2 emissions (Kim & Park, 2013), in the US, buildings use 38% (22% for housing) of the total energy (EIA, 2018)[2]. In Australia, 20% of greenhouse emissions are from housing (Australian Government, 2018). Various goals and targets have been set for the across the world. The 2008 Climate Change act passed in the UK calls for an 80% reduction in CO_2 emissions by 2050 as compared to the level in 1990 (UK Government, 2018). The projected increase in energy usage is cause for concern.

Projections from CSIRO give an increase of 0.4–2.0°C by 2030 and 1.0–6.0°C over the next 50 years in relation to 1990 levels (Hughes, 2003). Australia has seen a 56% increase in energy used by the housing sector over the last 30 years (Australian Government, 2018)]. This increase in predicted energy use is embodied in part by the need for more housing and development, as there is the anticipation of a population increase over the three next decades. For instance the countries in the Middle East and North Africa are predicted to have a population increase to 700 million people by 2050 (from 400 million currently) (Roudi-Fahimi & Khan, 2011). Honour (2010) gives an estimate of 600,000 residential refurbishments needed in the UK to achieve the goals of the Climate Change Act. In Australia, the Department of the Environment, Water, Heritage and the Arts report an increase in the number of occupied households of 61% between 1990 and 2020 (Australian Government, 2018). Therefore, there is a critical need for efficiency.

This concerns both efficiency in managing the construction process and efficiency in the operation of the building environment. It is also clear that without a coordinated approach, with the best of human knowledge being disseminated and utilised within industry, too many unsustainable trends will continue to unfold. We use word 'coordinated' as unrestrained growth in inherently unsustainable. In this research, we highlight the need for building information modelling (BIM) in the building sector, used not in isolation, but as an integrated approach. After a brief presentation of what is BIM and the method used to assess it against design integrated approach, following sections present case studies prior to the discussion and conclusion.

METHOD

Building information modelling (BIM)

Building Information Modelling is a way of sharing data across multiple domains. Born from the need to develop better and more comprehensive integrated approach in design practices, BIM is 'a process for creating and managing all of the inofmrationon a project-before, during and after construction' (Aconex, 2018) which takes the shape of the 3D design but is far from being reduced to it. For example, it can incorporate data such as energy analysis and other forms of optimisation. In the context above-mentioned many of the set goals that have been legislated call for an increase in efficiency. Kim et al (2013) quote the definition given by the US department of Housing and Urban Development for 'affordable' housing to include the costs associated with running a house (for example heating and cooling). Modelling and simulating allow designers to give proof of what the energy usage of a proposed structure will be.

Another important feature of BIM is that BIM is, at a minimum, three dimensional with phasing allowing a timeline (4D and above). The integrated process of sharing a model means that there is a feedback loop allowing optimisation prior to construction.

Having a 3D model over 2D drawings, means that more complex designs can be analysed and simulated. It is already quite common for much of the fabrication such as manufacturing HVAC ducts which use the BIM data directly.

Another element of BIM concerns the fact that having detailed models reduces the errors and requests for information during the construction process which in turn increases the efficiency of construction. There is also room for optimising the movement of material across projects. Kim et al (2013) cite a 40% reduction in total project cost when BIM was used. The savings from proper optimisation also have potential to be incredibly large but this is harder to quantify as not all BIM practices include the use of energy analysis.

A BIM model is a much more robust way of storing the needed data about a particular structure. The UK and Singapore Government mandate the use of BIM for construction projects. This leads to more efficiency in versioning and being able to understand the different updates that a building has over its lifecycle. For the controlling entity i.e. the local council, having a model of the built environment allows the making of predictions and the coordination of development. Having a form of visualisation also gives the potential for larger stakeholder participation. An exciting branch of this, is community participation in public projects.

Method

Ultimately, the value of BIM is that it acts as a common language for the different disciplines. As a result, it is only effective, if industry works to given standards and there is a sufficient level of sophistication in the 'virtual construction' of models. As mentioned, one of the most underutilised areas within the construction and development is in energy analysis. In this paper, we look at three domains of analysis within a building information model. These are lighting analysis, thermal analysis, and ventilation simulation. Each of these will be reported on with respect to where they currently sit within the integrated delivery process. These case studies aim to highlight the complexity of multi-disciplinary design by looking at the inputs, outputs, stakes within the field. The relationship of the field to BIM and the issues related to a centralised model are also explored.

LIGHTING

Advanced lighting simulation tools aid designers to understand light behaviour in a building and make it possible to evaluate design alternatives from a lighting and visual comfort perspective at the very early stages of design. Simulation tools also are also beneficial alternatives in situations where placement and maintenance of sensors is a high-priced option (Bhavani & Khan, 2011). Due to the impact of lighting design on building performance and energy expenditure, as well as occupant health and wellbeing, simulation tools play an effective role in creating high-performance buildings.

Outcomes of simulations and analysis

Lighting simulation tools such as DIVA and DAYSIM provide information namely, radiation maps, time-lapse images, point-in-time glare, annual glare metrics, the daylight factor (at a point in time or averaged), illuminance (SI units lux), LEED-IEQ-8.1 Compliance reports, climate-based metrics and load metrics.

Stakes

Daylighting determines the controlled utilization of natural light in and around buildings (Reinhart, 2014). It is the practice of placing glazing areas and reflective surfaces in a way that natural light provides effective internal illumination during the day. An effective

daylighting allows for adequate illumination to perform visual tasks, creates an attractive visual environment, and saves electrical energy and to provide the light required for occupant's biological needs. A quality luminous environment is simultaneously pleasant, comfortable, and appropriate for its intended uses and users and impacts user's productivity, mood, health and well-being as well as energy consumption (Lam, 1977).
A poor daylighting design will end up either with inadequate amounts of light – resulting in the need for electric lighting - or excessive amounts of light, accompanied by glare Boyce et al., 2003).

The work-life of most occupants comprises of many different visual tasks, and consequently changing demands on the lighting provided. Visual comfort and performance can be affected by the light variation within our field of view. For good visibility, some degree of uniformity of light is favourable. Visual discomfort, such as glare, and poor visibility may arise due to quick adaptation to a wide range of light levels.
Too low or too high contrast can also lead to discomfort, tiredness and headaches. In general, the human eye can tolerate greater luminance variations in a day lit environment than when they are artificially lit. Glare can be experienced when luminance variations exceed 20:1 to 40:1 (Rea, 2000). In this situation, the eye adapts to the higher level of the glare source, which makes it difficult to perceive details in the darker working area. Glare from daylight may be caused by various potential sources such as the sun, bright sky and clouds, and surfaces reflecting the bright light.

Data needed for Simulation

Lighting simulation tools typically have several models built into them:

- *Sky model:* In daylighting design, the daylight predictions and calculations are the basic prerequisites to predetermine design consequences and to create desired ergonomic conditions in interiors. For this reason, exterior lighting conditions are to be assumed or standardized. Thus, different CIE sky conditions such as overcast, clear etc. are accommodated. Though these sky standards do not have components for meteorological data of sunlight or cloud cover, they provide a sufficient reference for sky luminance distribution;
- *Room model:* The room model includes information about room geometry, partition, door, the placement and size of windows, furniture, as well as the physical properties of the material in room components such as reflectance and transmittance;
- *Process model:* Radiosity and ray tracing methods are used in different simulation softwares for the light process;
- *Occupancy model:* The occupancy model defines using hours of the space and is being used to create, record, interpret and analyse lighting performance based of occupancy pattern of the given space (Bhavani & Khan, 2011);
- *Weather data:* Models for incorporating weather data, solar radiation, wind speed, external illuminance etc. can be a part of some simulation programme by which the users can analyse the thermal comfort bands on a zone level along with the daylight process model (Bhavani & Khan, 2011);
- *Sensor point description:* Apart from producing a picture that has the photometric information for a given camera view and scene description, Radiance can also compute lighting levels at a specific location inside a given space by specifying a sensor point. The sensor point is specified by giving the X, Y and Z coordinates

and view directions at which Radiance calculates the illumination levels (Kota et al., 2014).

Simulation Challenges

Sky modelling, the time complexity of software towards real-time control applications, validation and energy simulation are some of the challenges in the simulation. The variation of daylight presents a challenge along with the calculation of interior light, solar gain and glare in sky modelling. This is due to the fact that diffused or reflected light by neighbouring buildings or some other objects and not uniform cloud conditions are not considered. The time-consuming process of generating accurate rendering is another issue which imposes high computational expenses. The lighting simulation software requires huge amount of empirical data for the validation process. The simulation output can only be verified if the actual scenario is available in a real building under operation. Thus, a comprehensive information on building usage and the corresponding data of real buildings are essential for simulation validation (Bhavani & Khan, 2011).

Using Building Information Modelling

Not only do BIM tools assist designing buildings utilizing 3D graphics, but they also are capable of having non-graphical information like material properties regarding the building elements, which are not accessible in CAD tools. It is also very straightforward to parametrically alter the BIM object dimensions and spaces with the geometry updating automatically based on any change. BIM is not only utilized to produce building geometry, but it also acts as a storeroom of the building information, which can be retrieved to perform various analyses on buildings, namely daylighting analysis, energy analysis, cost estimation, and structural analysis (Kota et al., 2014).

Translation problems with BIM

BIM does not have all the information that is necessary for creating the simulation input files for Radiance and DAYSIM; however, it provides options to incorporate the required information. Besides, the representations of the same building elements are not the same between Revit and Radiance/DAYSIM. Even by using the utility geometry information could be exported but the manual assignment is required for materials (Kota et al., 2014). The process of translating the Revit model into the Radiance input file consists of many steps. Additionally, in order to carry out the process, a well-rounded knowledge regarding each tool is required, which can be a paramount challenge for even an experienced designer. In design software, changes in design owing to performance criteria ought to be done manually, the model has to be exported and simulated again. After each change in design, these steps need to be repeated (Kota et al., 2014; Schlueter & Thesseling, 2009).

Overlap with other Domains

An area where lighting simulation overlaps or creates constraints with, is thermal design as the more glazing is used to allow daylight in, the higher the heating load from solar radiation. Conversely, light wells and aria which provide light, can also be used to increase ventilation due to the stack effect. The data from a lighting simulation, such as the nature of a shading system can be used as input for a thermal simulation and the results of ventilation studies can be used to inform the position of windows.

THERMAL SIMULATION

Thermal simulation differs from lighting simulation in many respects. While point measurements are made in lighting design, the energy used for thermal systems is virtually always over longer periods of time – months or years. The energy behaviour of a building is influenced by a large number of factors, namely, ambient weather conditions (particularly the dry-bulb temperature), building location and geometry, the building construction and thermal property of the physical materials deployed, general operation of the building, all interior load values (plug loads, occupant numbers and activity level), zoning requirements, the operation of sub-level components like HVAC (Heating, Ventilating, and Air-Conditioning) systems, their performance and schedules. Suitable BSPs, skilled users, and quality assurance techniques are required for effective application of building simulation. Additionally, performing building simulation requires absorbing the nature of the issue to be solved, using a proper simulation program, and making decisions based on interpreting the simulation results professionally.

Outcomes of simulations and analysis

The application of computer-based tools in the building industry can be mainly categorized into two groups: computer-aided documentation, as well as computer-based simulation (Hong et al, 2000). The first application that usually utilizes personal computers to create technical documents and drawings, has been popular with building designers and it has scant effect on efficient building performance. The latter application usually needs the employment of engineering tools to calculate space heating/cooling loads and envelope heat gains which are the basis for the sizing and selection of HVAC equipment, predicting the energy condition of buildings and cost, analyse thermal comfort, and supply diagnostics to enable automatic control of systems and plant operation. Energy-efficient buildings can be realized by virtue of analysing the part-load performance of major energy-consuming equipment along with annual building energy demand. Moreover, innovative techniques for energy saving such as green roof, radiation cooling, solar hot-water heating, heat recovery, and thermal storage, to name but a few can be evaluated before implementation. Building simulation is supposed to be a cutting-edge method to substitute energy-heavy buildings with energy-efficient thermally conducive buildings, thereby changing the application of energy simulation in green buildings to a must, as opposed to a need.

Stakes

Although using Environmentally Sustainable Design principles in the design and construction of buildings can contribute to paramount advantages, improper design will have some undesirable effect such as:

- Higher costs due to expensive energy bills owing to more dependence on active heating and cooling systems
- Deteriorated living comfort due to less-uniform interior temperatures
- Increased building’s carbon emissions.
- Lower investment returns without an optimised thermal envelope, the embodied energy, heating and cooling energy and resource usage is more than required.

Data needed for Simulation

Simulation tools are contingent upon physical principles; thus, in order to obtain an accurate simulation, they need precise details of building and environmental parameters in the input data. However, this information is usually unavailable for most case studies,

for example, obtaining the information of each room in a large building is invariably difficult. Therefore, the lack of accurate inputs would bring about a low accurate simulation. Operating these tools usually also needs heavy expert work, making them costly and difficult to perform. For these reasons simpler models are proposed to offer alternatives to certain applications. Further, weather data is an important factor to determine building energy usage. This takes many forms, namely, temperature, humidity, solar radiation, wind speed, and vary over time. However, gathering all the information to make accurate weather data is not straightforward, for example, taking the sky factors covering into account usually involves an extremely simplified mathematical of the sky (i.e. the standard CIE sky set). Another significant issue in building energy simulation is calibration (Pan et al., 2007). By tuning the inputs meticulously, it can accurately match the simulated energy behaviour with the real building. As calibration is a complicated and time-consuming work, performing an accurate simulation by a detailed engineering method is highly complex.

Using Building Information Modelling

Laine et al. (2007) listed the benefits of using BIM for thermal performance management, these include:

- Data input for energy analysis becomes far more efficient and the existing data becomes more reusable;
- Rather than traditionally utilized static calculation methods, BIM based environment permits the utilization of dynamic thermal simulation;
- As opposed to traditionally utilized zonal models, BIM based environment allows dynamic energy simulation by means of a whole building spatial approach;
- BIM permits more straightforward verification of the thermal performance in various phases of the building process;
- As the starting point for the HVAC system design, BIM based environment permits a straightforward way to use simulated values from thermal analysis;
- Employing BIM supports to proceed with thermal performance tracking during operation and maintenance.

Translation problems with BIM

The main translation problems in the uptake of BIM to thermal simulation are:

- The scarcity of guidelines as well as the missing interoperable data interface implementations in thermal simulation tools;
- Being a single detailed model. BIM does not permit the managing of “what if” scenarios or alternative design options. In other words, the process of efficiently creating multiple alternatives is still not a reality in practice;
- The complexity and size of BIM. The large size of BIM needs dissimilar means of data sharing, and real time access into the database would need broadband internet access, together with security of data being worked on.

Overlap with other Domains

Thermal versus visual comfort is really a challenge since when visual and thermal considerations are bound together satisfying one criterion will come on the expense of the other. The assumption that when a drop in solar gain is required, also less visibility is acceptable may limit the users to achieve comfort in merely specific conditions.

VENTILATION

Simulating airflow and ventilation tends to be rarer in the building industry compared to the other two forms of simulation. It can however be very critical from the point of view of sustainability as increased natural ventilation is an efficient way to cool across most climate zones. This section is covered more briefly than the previous two as many of the issues have already been mentioned.

Outcomes of simulations and analysis

The outcome of a computational fluid dynamics (CFD) simulation is a map of the air velocity through the building for a segment of time. The expensive nature of CFD simulation, combined with the accumulative error mean that the simulation is not performed for extended periods of time. The data can be used to make assessments about comfort levels and to position openings such as to maximise ventilation within the allowable limits. It is also more common to simulate individual spaces with defined boundary conditions rather than whole building simulation.

Stakes

The downside of badly designed airflow includes draughts, excess noise and uncomfortable spaces (either too hot or cold). The downside of a badly designed natural ventilation solution becomes the increased dependence on air-conditioning and the energy costs that follow.

Data needed for Simulation

The main input needed is the geometry of each room, though this has to be heavily simplified. Most CFD analysts use a finite difference scheme for simulation, to the space is discretised into a 3D grid for the air velocity to be calculated at each point. The simulation requires the input and output mechanisms for the air – the terminal elements of the HVAC system.

Using Building Information Modelling

Lee and Song (2010) present solutions for using CFD with BIM in the early stages of the design project. The area of optimisation of airflow has a lot of potential for using advanced modelling methods such as parametric modelling as geometries can be constrained and defined with airflow as the main parameter for optimisation. O'Grady and Keane (2006) present the specifications with the IFC standard for utilising CFD analysis from BIM and the technical issues related to translation. They also propose an implementation for an interface.

Overlap with other Domains

Obviously creating openings affects both the thermal and visual design aspects of the project. For the most part, ventilation studies need to be done in conjunction with thermal analysis. In the case of using atria or other features intended to increase ventilation rates, design aspects such as spatial planning are affected, and these become part of the design concept rather than simply an add-on that can be optimised in isolation.

DISCUSSION

As seen with the previous case studies, some opportunities have emerged in the field of integrated design with an emphasis on building performance simulation. They are being discussed in the following lines.

Use of cloud-computing

There is a considerable gap between the architecture, engineering and construction (AEC) industry and the state-of-the-art in collaboration within the software development industry. Software developers have created systems to work in large teams, concurrently, and with the system support of tracking changes, version control and commenting. The use of cloud-based software to replace common desktop applications such as text-editing, spreadsheets and presentations through services such as *'Google Docs'* has also become commonplace. In the gaming industry, massive-multiplayer-online-games have become popular. In these virtual worlds, hosting thousands of users is common place. In this regard, online collaboration in the AEC industry is still in its infancy. A review of building information modelling with cloud computing is given by Wong et al. (2014), who identify the FM and energy management stages of the buildings lifecycle as areas for expansion. Working with across a common platform would allow simulation specialists (lighting, cooling, ventilation, etc.) to give input at an earlier stage of the design process.

Use of Advanced Modelling

Davis (2013) provides advances in the software development industry as inspiration for more flexible and robust computer models for the AEC industry. Methodologies for software development include Agile development, Crystal methods, Scrum and Adaptive Software development (Highsmith & Cockburn, 2001). These practices include defining constrains, contracts and protocols and automated testing which is run frequently. It is easy to imagine that building performance simulations are used as tests while the building design is under development. However, this process is far from automated as it currently stands, though experimental work in research, through softwares such as McNeel's Rhino and Grasshopper are making strides towards this.

At the forefront of modelling the AEC industry is parametric modelling, where relationships and constraints are described in the model in order to make it more flexible. Incorporating such methods into energy use simulation could make it easier to produce and test options. GenOpt was an early attempt to provide this for users of EnergyPlus (Wetter, 2000). Other generative modelling methods include evolutionary modelling (Janssen, 2005) and related optimisation procedures. Within specific fields such as HVAC energy optimisation, the use of genetic algorithms (GAs) have been explored (Huang & Lam, 1997). GAs have also been used in lighting optimisation (Ferentinos & Albright, 2005) and more generally in design (Caldas & Norford, 2002).

Object libraries within the space of building information modelling have become commercial entities with many manufacturers providing the geometric as well as meta-data of their products. With the linking of BIM to energy analysis, the goal is to reduce the time taken to ready a model for simulation.

Use of Multi-objective Optimisation Methods

As stated earlier, with an integrated approach to project delivery, the complexity of navigating the solution space rises. Value judgements need to be made and a view of the project as a whole, needs to be frequently examined. Holzer (2009) criticises the silos that the various disciplines form within the AEC industry and presents a thesis of how multidisciplinary collaboration might occur and a methodology based on *optioneering is*

put forward (Holzer, 2009). With advances in modelling methods and platforms for collaboration across networks even across timelines and national borders, there is more opportunity for the various design participants to understand the project holistically and to tailor their input with a holistic view. Therefore, there is an opportunity undertaking research regarding human-computer interaction and the navigation of solution space as well as methodologies as to how the different stakeholders reconcile qualitative and quantitative aspects of the design project. An experimental method for exploring design space is given by Holzer & Downing (2010) who use this in application of designing retrofitting solutions.

Accelerated processing

The advancement of computer hardware has been utilised by researchers looking at proving real-time results. One of the most computationally expensive forms of simulation – computational fluid dynamics can benefit heavily from these advances. These include, utilising GPU processing (Tolke & Krafczyk, 2008), parallel processing (Tian et al, 2017) and software solutions such as coarse grid modelling (Liu & Chen, 2017). The use of real-time rendering (which had already made a huge impact on the Architecture Visualisation industry) has the potential for also providing lighting analysis (illumination, glare, day factors). The use of scanning technologies (LiDAR, photogrammetry) coupled with increased processing power can translate to more accurate site models. Methods of artificial intelligence (neural-networks, genetic algorithms) have also become more accessible, though too vast to enumerate.

CONCLUSION

In this paper, the importance of the industry moving towards an integrated design platform was highlighted. The ultimate aim of such platforms is the elimination of repetitive work through well-designed components, to streamline the process of translation, to bring in expert advice as early as possible into the design process, to work through different variations and to make the process more transparent in order to give the stakeholders a holistic view. Building information modelling used well becomes the design stages of a project and can be used, post-occupancy for facilities management, energy management and even as far as demolition. The importance of having building data that is clearly defined, tracks changes, alterations and services becomes ever-more important as the built environment expands, new levels of density are reached, and infrastructure is upgraded. With the predicted increases in construction and population, it is becoming an ever more critical goal that we set up feedback loops in both the design and construction stages of design. Coordination through building information modelling is a step towards this.

REFERENCES

Aconex (2018), retrieved from https://www.aconex.com/what-is-BIM

Kim, K.P. and K.S. Park (2013) BIM feasibility study for housing refurbishment projects in the UK. *Organization, technology & management in construction: an international journal*, **5**(Special): p. 765-774.

EIA. 2018; Available from: https://www.eia.gov/tools/faqs/faq.php?id=86&t=1.

AustralianGovernment. (2018); Available from: http://www.environment.gov.au/resource/help-prevent-climate-change.

UKGovernment. (2018); Available from: https://www.legislation.gov.uk/ukpga/2008/27/contents.

Hughes, L. (2003) Climate change and Australia: trends, projections and impacts. *Austral Ecology*, 28(4): 423-443.

Honour, J. (2010) *Sustainable housing refurbishment: an update on current guidance and sources of information*. Watford: IHS BRE Press.

7.Roudi-Fahimi, F. and M.M. Kent (2007) Challenges and opportunities: The population of the Middle East and North Africa. *Population Bulletin*. 62(2): 24.

Bhavani, R. and Khan M. (2011) Advanced lighting simulation tools for daylighting purpose: powerful features and related issues. *Trends in Applied Sciences Research*. 6(4): 345.

Reinhart, C.(2014) *Daylight Handbook I: Fundamentals/Designing with the Sun.* United States of America: Christoph Reinhardt.

Lam, W. (1997) *Perception and lighting as formgivers for architecture*. McGraw-Hill.

Boyce, P., Hunter C., and Howlett O. (2003) *The benefits of daylight through windows.* Troy, New York: Rensselaer Polytechnic Institute.

Rea, M.S. (2000) *The IESNA lighting handbook: reference & application.*

Kota, S., et al. (2014) Building Information Modeling (BIM)-based daylighting simulation and analysis. *Energy and Buildings*, 81: 391-403.

Schlueter, A. and Thesseling, F. (2009) Building information model based energy/exergy performance assessment in early design stages. *Automation in construction*, 18(2):153-163.

Hong, T., Chou S., and Bong T. (2000), Building simulation: an overview of developments and information sources. *Building and environment*, 35(4): 347-361.

Pan, Y., Z. Huang, and Wu G. (2007) Calibrated building energy simulation and its application in a high-rise commercial building in Shanghai. *Energy and Buildings*. 39(6): 651-657.

Laine, T., Hänninen R., and Karola, A. (2007) Benefits of BIM in the thermal performance management in *Proceedings of the Building Simulation*

Lee, S. and Song D. (2010) Prediction and evaluation method of wind environment in the early design stage using BIM-based CFD simulation. in *IOP Conference Series: Materials Science and Engineering*. IOP Publishing.

O'Grady, W. and Keane M. (2006), *Specification of an IFC based software application to support CFD simulation.* ICCCBE 2006.

Lydon, G., M. Keane, and D. B. Ingham (2005), *Implementation of an Interface between a CFD Energy Analysis and an IFC Building Product Model*. 277-286.

Wong J, W.X., Li H, Chan G, Li H. (2014) *A review of cloud-based BIM technology in the construction sector*. ITcon, 2014. 19: 281-291.

Davis, D. (2013) Modelled on Software Engineering: Flexible Parametric Models in the Practice of Architecture, in *Architecture and Design.* RMIT University.

Highsmith, J. and A. Cockburn A. (2001) Agile software development: the business of innovation. *Computer*, 34(9): 120-127.

Wetter, M. (2000) Design optimization with GenOpt. Building Energy Simulation User News. 21: 19-28

Janssen, P.H.T. (2005) *A design method and computational architecture for generating and evolving building designs*. The Hong Kong Polytechnic University.

Huang, W. and Lam H. (1997) Using genetic algorithms to optimize controller parameters for HVAC systems. *Energy and Buildings*, 26(3): 277-282.

Ferentinos, K.P. and Albright L. (2005), Optimal design of plant lighting system by genetic algorithms. *Engineering Applications of Artificial Intelligence*, 18(4): 473-484.

Caldas, L.G. and Norford L.K. (2002), A design optimization tool based on a genetic algorithm. *Automation in Construction*, 11(2): 173-184.

Holzer, D. (2009) Sense-making across collaborating disciplines in the early stages of architectural design, in *Architecture and Design*. RMIT University.

Holzer, D. and Downing S. (2010), Optioneering: A New Basis for Engagement Between Architects and Their Collaborators. *Architectural Design*, 80(4): 60-63.

Geyer, P. and Schlüter A. (2014) Automated metamodel generation for Design Space Exploration and decision-making – A novel method supporting performance-oriented building design and retrofitting. *Applied Energy*, 119(Supplement C): 537-556.

Tölke, J. and Krafczyk M. (2008) TeraFLOP computing on a desktop PC with GPUs for 3D CFD. *International Journal of Computational Fluid Dynamics*, 22(7): 443-456.

Tian, W., T.A. Sevilla, and W. Zuo (2017) A systematic evaluation of accelerating indoor airflow simulations using cross-platform parallel computing. *Journal of Building Performance Simulation*, 10(3): 243-255.

Liu, W. and Chen Q. (2017) Development of adaptive coarse grid generation methods for fast fluid dynamics in simulating indoor airflow. *Journal of Building Performance Simulation*, 1-15.

BIM ATTRIBUTES FOR ADDRESSING THE CAUSES OF DISPUTES IN CONSTRUCTION PROJECTS

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Abstract
Considerable concern has been expressed in recent years regarding the dramatic increase in conflicts and disputes in the construction industry in many countries including Australia. These conflicts and disputes resulted in a high cost to the industry both in terms of direct costs (lawyers, claims consultants, management time, delays to projects completions) and indirect costs (degeneration of working relationships, consequences of mistrust between participants and lack of teamwork). The nature of the construction disputes is complex, dynamic and multi-faceted. In addition, it is not only confined to disputes between the client and main contractor, but it occurs between the prime contractor, sub-contractors, consultants and designer. The alternative dispute resolution (ADR) is any procedure or combination of procedures, conducted in a controlled structured manner, which is entered into voluntarily by the parties to a dispute, as opposed to one using the other publicly in an open court. This research reviewed the literature to provide a comprehensive discussion and analysis on the root causes of disputes in the construction industry. The relationships between the parties involved in a construction project are also defined along with the potential of disputes in each relationship. Furthermore, the paper comprehensively explained how BIM could be used as an ADR in construction project phases including tender, engineering, procurement and construction.

Keywords: construction disputes and conflicts; alternative dispute resoultion; BIM.

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CAUSES OF DISPUTES IN A CONSTRUCTION PROJECT

To identify the types of disputes, this research identified the nature of relationships in the construction industry. According to Hallard (1987), the construction relationships can be categorised as Owner-Designer; Designer – Design Specialists, Owner – Prime Contractor, Prime Contractor – Subcontractors and Prime Contractor – Suppliers. Although in different types of contracts such as EPC, BOO, EPCM and DBFO, the relationships might differ slightly from the above. However, this categorisation stands correct for the majority of contracts in the construction industry. According to Halki principle, a dispute does not exist, until a claim has been submitted and rejected. So based on this definition, the primary cause of disputes are claims made by any parties involved in a construction contract. The claims can be made due to a broad variety of reasons (Otoo 2010; Yates 1998).

Building information modelling (BIM) can address the disputes in all phases and aspects of projects, including Tender, Engineering, Construction, and Procurement. A perspective on the roots and causes of disputes initiated in all these phases can lead us to a better understanding of the problem and how to address each of them using BIM. Table 1 lists the different causes of dispute and corresponding BIM feature to be implemented to eliminate the cause effectively.

Table 1 BIM capacities to eliminate causes of disputes in construction projects

Construction Phase	**Nature of Dispute**	**BIM Attribute**
Tender	Estimating Errors	More realistic BoQs and estimates by envisaging the project outcomes
	Unclear Scope of Work	The ability to visually determine a solid scope and division of work
	Potential Change Orders	The ability to check the fulfilment of the conceptual design by visualising the project's outcome
Engineering	Poor Design Quality	By building a virtual model of the buildings the omissions and deficiencies will be detected
	Lack of Constructability	By building a virtual model of the buildings, constructability issues will be prevented
	Disciplines Drawings Discrepancies	By building a virtual model of the buildings, the clashes will be discovered and tackled
Construction	Tasks Interdependency	A visual division of work and time dependencies of the activities in all disciplines
	Sequence of Activities	Modelling the entire project according to the basic activities derived from the preliminary design
	Machinery & Manpower Demand	Determining the most efficient demand by modelling the work environment and sequence of activities
	Safety	Identifies the potential hazards and proposes appropriate control measures
	Time Frame and Schedules	4D BIM anticipates the activities according to a visual model and assigns realistic time frame

	Payments to Contractors	Provides a solid evidence to specify the proper time for submitting and approving the invoices
Procurement	Materials Spec & Availability	Provides a procurement plan based on 4D BIM to determine the proper time for purchase and shipping
	Purchase & Delivery Time	Physically envisioning the project phases and extract accurate information for procurement

The remaining of this research elaborated the reciprocal relation between dispute causes and recognised BIM attributes in different phases of a construction project. As demonstrated in Table 1, the construction disputes are covered across four main project phases (tendering, engineering, construction and procurement). Additionally, Table 1 demonstrates the BIM attributes for each dispute. These phases and its disputes are explained as following.

BIDDING PHASE

Generally, when the feasibility studies, preliminary design and basic design are completed, the client starts bidding for the project. At this stage, a holistic perspective of the project has not been developed yet. This immaturity can lead to multiple disputes later on during the construction phase.

Estimating Errors

Preparation of Bill of Quantities (BoQ) and subsequent estimating is the cornerstone of every construction project. Errors at this stage potentially lead to unrealistic tendering by a potential contractor. Many of the change orders issued by the clients are caused by the lack of an adequate understanding of the needs and requirements of the projects at bidding stage. Therefore, clients need to have a means to enable them to envisage the outcome of the project. A means which can also play as a reliable source for extracting BoQs and estimates. Given the attributes and features of BIM like dimensioning the structures to the precision required in the calls for tenders (Koppinen, Tiina, Skanska Oy, Finland; Kiviniemi, Arto (2008). It can conveniently play such an important role.

Unclear Scope of Work

A construction project is comprised of a broad variety of activities which may differ from one project to another. At the bidding stage of the project, having a thorough perspective on all these activities is almost impossible, and many of them emerge at the construction phase. On the other hand, contractors plan on the activities which are assigned to them by the terms of the contract and are extremely unwilling to take one step further than it is specified in the scope of work defined at the beginning of the project unless with an addendum ensuring the extra payments. This problem occurs more prominently, especially when multiple contractors are engaged in a project. Ambiguity in the project's scope is a root for disputes between the client and contractors. This can lead to severe disputes during the construction phase and put the entire project on hold until a proper settlement is reached, which may take months to be agreed by all parties. BIM provides all the parties involved in a construction contract the ability to visually determine a solid scope of work to prevent all time-consuming disagreements regarding the division of fronts and works (Azhar, Nadeem, Y N Mok, & H Y Leung, 2008).

Potential change orders

Change orders are another problem causing disputes which is a result of lack of proper perspective on the project by the Client. BIM enables the project leadership to virtually construct a building before setting up the construction site. The scope of a project undertaken by each contractor can be visually illustrated at the bidding stage. This can also enable the client to make sure that the outcome of the construction phase can fulfil the conceptual design to prevent any change orders during the construction phase.

ENGINEERING PHASE

Generally, it is during the construction phase of the projects where design defects are detected. The problems initiated in the Engineering phase of the project are mainly a) Poor design, b) constructability issues and c) Discrepancies in details provided to different teams.

Poor design quality

Design drawings are generally incomplete, and they are not explicit. Very often design documents have inconsistencies, errors, ambiguities, and omissions, or lack clarity in presentation. These problems, when detected during the construction phase are referred to the client through Request for Information (RFI) or Design Team Query (DTQ), issued by the contractor. Due to paper works and formalities, the simplest enquiry takes a few days to be responded by the Engineering team of the client or the consultant. Regarding everyday costs of a construction site, borne by the contractor, before submitting the queries or during the waiting period for a response, the Engineering teams of the contractor, located at site try to figure out the problems on their own to prevent further delays. In this manner, all the efforts of the contractor's Engineering teams, instead of being assigned to meet the milestones of the projects and advancing the construction activities, will be wasted on identifying, reporting and following up correspondences related to a poor design quality, a problem which could be prevented mostly at the Engineering phase of the project, if the drawings produced are used initially to build a virtual model of the buildings. In this manner, many of the ambiguities will be discovered, and associated with future disputes will be prevented. BIM enables the Engineering teams on both sides of the contract to do this productive practice (Linderoth et al. 2014).

Lack of constructability

An important proportion of the problems detected during the construction phase is due to the lack of constructability of the design. This is a more serious problem than the latter. Because issues with constructability are not kinds of problem which can be resolved by the Engineering teams at the site. Accordingly, significant delays are expected when issues regarding constructability are raised. Due to the nature of this problem, reassessing the design and redesigning some structural elements will be inevitable, during which the associated working fronts at the site will be frozen until a proper remedial plan is prepared. The constructability issue can also be tackled by the tools BIM provides for the design team, in the same manner, that it prevents a poor design quality (Hijazi, W., Alkass P, S., Tarek, & Zayed, T. (2009).

Discrepancies between the drawings for different disciplines

Each engineering discipline team at the site have specific timetables and defined milestones to meet. So the first result of any clash between the drawings for different disciplines, before referring it back to the designers is a conflict between the engineering

teams at the site. The best case scenario for such clashes is that they are discovered by the contractor's engineering teams before entering the construction phase at the corresponding work front. However, in most cases, the worst case scenario happens, in which one discipline proceeds with the activities as per their drawings and then when another discipline is handed over the front to start their works, the discrepancies are discovered. In the latter case, a rework is due, which includes dismantling or demolition, the nightmares of any contractor.

The matter of clashes between the disciplines is harsher than the other problems in the engineering phase. It is not discovered until the engineers from different disciplines sit together to asses and compare the drawings which belong to the same work front. This practice is conducted in many construction sites with proper management. However, the time and energy of the teams are wasted this way, to deal with a problem which could be prevented in the first place. Another aspect of severity of this problem is that when it is referred to the designers, it takes a long time to process and redesign, during which the contractor has no other alternative but to wait for a practical response by the designer (Tan 2010).

CONSTRUCTION PHASE

Most of the disputes and clashes emerge in the construction phase. Whereas they are initiated in other phases, such as tender and engineering. Claims and disputes are inherent parts of everyday life in every construction site, and without settling them in a proper timeframe, the project fails to meet the milestones planned in the project's schedule. To deal with these everyday disputes, a great deal of time and effort of the management and engineering teams are wasted. The precious time and efforts which are to be assigned to what they are meant for in a construction project; leading engineering and labour teams, investigating resources, preparation of invoices and bill of quantities, supervision, making registers and records of the activities, planning for the activities, preparing reports, anticipating and applying for required permits, etc.

The majority of disputes during the construction phase are initiated during the design phase of the project and caused by deficiencies in the drawings and engineering documents. However, the disputes during the construction phase are not only confined to the engineering documents are elaborated below.

Tasks Interdependency

At the beginning of every construction project under proper management, there is a liaison meeting among the participating engineering teams from different disciplines. These meetings are held to found a structure and system for the disciplines to interact during the project, and to prevent any possible clash among them. During the first stages of the project, this liaison is more crucial. Executing earthworks and foundations need continuous communication among the disciplines since they include most of the substructure of mechanical and electrical works. Without a proper communication at this stage, reworks and demolitions will be inevitable.

Before starting up the project, the interdependency of the activities within a discipline and also in conjunction with other disciplines is to be defined and determined. The best way to illustrate such interdependency is using BIM which provides us with a visual division of work and time dependencies of the activities in all engineering disciplines. The clashes caused by unclear interdependencies not only lead to costly reworks or demolition, but also can cause degeneration of professional relationships between the engineering teams at the site. Lack of a clear interdependency plan makes the engineering team like isolated islands proceeding with their working schedules.

Sequence of Activities

One of the crucial pieces of knowledge to make a good construction manager is to know the sequence of construction activities. Then putting the activities in an organised work breakdown structure, and determining the prerequisites of every single activity, and implementing a system on the construction site to monitor and supervise the activities to be undertaken according to the pre-defined sequence. Defining a proper sequence is more important when it comes to interdisciplinary activities. Generally, for this purpose, a construction manager will have a few meetings with the engineers from different disciplines to define the sequence and prepare a Work Breakdown Structure, concurrently with site set up and mobilisation.

At the beginning of every project, due to lack of a thorough perspective of the outcome, and only relying on the general knowledge acquired by experience and previous jobs, the unique characteristics of projects are neglected. Consequently, the sequence of activities might not cover all the activities, especially the ones with higher complexities. In case of lack of a profoundly defined sequence of activities, a construction site will suffer demolitions and reworks, as well as degeneration of relationships between the engineering teams as a result of these clashes. Even without a complete set of project drawings, BIM can model the entire project according to the necessary activities derived from the preliminary design. By visualising the project outcomes at each stage, the engineering teams will be able to predict the activities at each stage and have a more reliable resource to define the sequence of activities (Strafaci, 2008).

Disagreements over Machinery and Manpower Demand

Dealing with disagreements between clients and contractors is a daily routine in every construction site. Although some disputes can be settled by referring to the terms of contract or law, but not every dispute is addressed in those references. These disputes are raised by the different points of views of the client and contractor's representatives at the site. One of the most common of these disputes is the disagreements over the manpower demand by each activity.

For determining the workforce demand for each activity, clients and contractors might consider different criteria. For the client's representatives at site, the primary concern is for the project to meet its milestones without any delays, and not to fall behind the schedule. Whereas the contractors, other than the schedule, need to take into account some other criteria as well such as payments dates, overhead costs of machinery and manpower, prediction of peaks and hiatuses of activities, in order to leverage the limited budget and resources at their disposal so as to achieve the target profit they set at the beginning of the project. These two points of views cause constant disagreements over the adequacy of the plants and manpower to cover the ongoing construction activity. Since such a matter is not and cannot be addressed in a contract, it remains one of the most unsettled argument in construction sites. The client's representative (which in most cases is the Construction Manager) insists on increasing the quantity of plants and manpower, whereas the contractors resist to do so.

General rules and estimates made based on the magnitude of working front's dimensions or the volumes of materials can never be applied to this case. Such disagreements can only be resolved if a system is defined to precisely determine the required plants and manpower demand for each activity specifically for each project. BIM by considering the sequence of activities and modelling working environment, and also taking into account the timeframe of the project and important milestones of the schedule, can determine to the most efficient quantity of plants and manpower to undertake any activity at each stage of the construction process (Tulke and Hanff, 2007).

Disputes over Payments to the Contractors

Scheduled payments to the contractors and the disputes over the proper milestones for the payments to be made are basic elements in every construction project. Timely mannered payments, due to inconsistencies in the payment amounts and also not efficiently covering costs and expenses are not contractors' favourite method. Time-dependent payments are not in favour of the clients either. In this manner, at the end of each period (mostly monthly), the contractors prepare and submit their invoices to the client's representatives. These invoices include the bill of quantities and unit prices for each activity. The client will assess the invoices in a reasonable amount of time, and if the activities and quantities are approved, the payments will be made. Preparation of invoices, especially in large projects is a very time-consuming activity. Besides, a contractor might have had a large expense at the beginning of a period and needs to wait to the end the period to submit the invoice and get reimbursed. From the client perspective, in a timely based invoice system, a contractor is more likely to assign higher priorities to the activities which gain more profit, instead of the project's important milestones. Padding out the invoices by the contractors is also another likely problem caused by this method.

This is why a WBS based payment system is more favourable to all parties involved in a construction contract. The payments will be made at the milestones defined based on the physical progress of the project. Similarly, the payments are made based on the progress percentage of the project, and these percentages are defined by finishing a particular activity or a building. The definition of completion of activity might not be as clear as it seems in some cases. Especially when an activity involves several independent activities. This is where a dispute may occur at the time of payment. The best resolution for such a dispute will be a 3-dimensional model, in which all payments milestones are defined and illustrated visually. BIM will provide substantial evidence for both contractors and clients to specify the proper time to respectively submit and approve an invoice for payment (Hergunsel, 2011).

Disputes over Safety

Around 12600 workers' compensation claims are accepted from the construction industry each year in Australia, for injuries and diseases involving one or more weeks off work. In the construction industry, this equates to 35 serious claims each day. In 2012–13 the construction industry had the 4th highest incidence rate of serious claims per 1000 employees and fifth highest fatality rate per 100 000 workers in 2013–14 (Safe work Australia, 2017).

This brings safety to one of the highest priorities in every construction site. There are incessant arguments at construction sites over the adequacy of control measures undertaken by the contractors, and also providing sufficient supervision for implementing the control measures. The supervisions are conducted through the Health and Safety Environment (HSE) agents by constant patrols throughout the site. The points of views and methods of implementing safety control measures might differ from one agent to another. Besides, construction managers, regarding a higher level of legal accountability, tend to be stricter than the HSE agents and keep overseeing the safety-related activities. The HSE procedure for the project does not go deep into the specific details of the activities. They mostly discuss the proposed safety control measures for different construction activities in a general form. This leaves the door open for interpretation by the parties engaged in setting safety policies, and here is where disputes over safety emerge in construction sites.

One of the capabilities of BIM is to specify safety hazards associated with each activity at the site during construction (Zhang et al. 2013). BIM also proposes

corresponding control measures for the hazards. This can provide the construction managers with a reliable reference when it comes to disputes over the adequacy of the safety control measures and how to implement and supervise them on site.

Disputes over Time Frames and Schedules

At the tender stage of projects, based on the existing limited information, client demands that contractors must submit an appropriate work schedule according to the time frame set by the client. Especially in large and complex projects, contractors fail to foresee all the activities and consider every single of them while preparing the schedule. These unrealistic schedules due to lack of sufficient information and a holistic perspective of the project will be a constant subject of disputes in a construction project. These disputes not only impair the contractors financially not to fulfil the basic schedule according to the terms of the contract, but also leads to wasting hours of engineering and management manpower to discuss and argue over rescheduling the project, and especially in long terms projects, this rescheduling can occur several times during the construction phase. 4D BIM, anticipating all the activities according to a reliable visual model of the project, and assigning a realistic schedule for each activity, is a trustable means to overcome or mitigate the disputes over time schedules (Tulke and Hanff, 2007).

PROCUREMENT PHASE

Acquiring required materials, equipment and machinery with a reasonable price and at appropriate times is a crucial concern for every project manager. Without a proper procurement, the efforts of manpower in a construction site will go to waste. Making decisions on hiring or purchasing the required machinery is also a fundamental aspect of a procurement manager's job, which is not obtainable without reliable sources of information and a realistic time frame. Procurement phase of a construction project is very likely to be susceptible to disputes of its own.

Purchase and Delivery Time

A procurement manager is bounded by several factors for acquiring the needed goods; storage facilities on site, available funds and budgets, and a time frame dictated by the requirements of the construction activities. A right time to make a purchase is also subject to market fluctuations, primarily when the item being purchased (e.g. steel) is affected by international price fluctuations. In countries with weaker or unstable economies, inflation rates kick in to be a very influential factor when it comes to procurement. So one can assume that adding the pressures by the client to the factors above, can complete the ingredients for a dispute over the proper time to submit a purchase order. Shipment and delivery time can drastically differ from one item to another and manage a smooth procurement process requires constant planning, foreseeing the circumstances of market and experience. On the other hand, client's representatives on site always concern about any probable delays in items shipment and delivery. Therefore, they keep insisting on putting purchase orders at the earliest time possible.

A comprehensive procurement plan at the early stages of a project can benefit all parties involved and prevent potential disputes over the proper time for ordering materials and equipment. This procurement plan can be achieved by physically envisioning the project phases and being able to extract accurate information in terms of procurement. BIM is the tool we have available for this important purpose (Sacks, Treckmann, & Rozenfeld, 2009).

Disputes over Specifications and Material Availability

The design team at the engineering phase of the project, generally take the liberty of putting an ideal selection of materials, ideally in compliance with their design and also the equipment which are dictated by the client regardless of their availability at the procurement phase and the time of purchase. The problem is more likely to occur in the international project when the parties involved are located in different countries. Especially the design team, complying with their native standards and availability of the material in the local market, might merely neglect the fact that construction standards in different countries may suggest different specifications for the structural elements, such as steel grades and profiles. The problem does not materialise until the procurement unit prepares and submits a purchase order for the mentioned materials. The contractor fails to obtain the required material and is obliged to propose substitute materials. Apart from the massive paperwork to get the approval of the client and then redesigning the structural elements based on the substitute materials, the construction process may face delays due to this problem, and claims will be made by the contractor, blaming the design team as the culpable party for the delays. Substituting materials during the construction phase may also result in reworks at some fronts to make it compatible with the new materials (Gill et al. 2015).

A procurement plan, based on a 4D BIM will include required information on the material and their shipping and delivery time (Azhar, 2011). The information can be extracted from the BIM model at the design stage and will prevent costly and time-consuming clashes and disputes over the availability of the required material for construction.

SUMMARY

The construction industry is fraught with common disputes among involved parties. The disputes may evolve from a minor disagreement which takes minutes to resolve to complicated conflicts which have the potential to jeopardise the projects in multiple aspects. Construction disputes cause delays, which is considered as an essential root for loss of resources as well as project overruns. The disputes also contribute to the financial loss, degeneration of relationships between the parties, and time-consuming arguments which make the potentials of the engineering and management teams of all parties to go to waste. According to the extensive literature review conducted in this paper, BIM enables the project management to overcome the potential problems caused by common disputes within a construction project phases. Implementing a BIM unit, as an independent party involved in a construction project, functioning as a bonding agent for the engineering teams of contractors and consultants is proposed, which can significantly contribute to dispute resolution. The nature and type of interaction between the BIM unit and other parties is the material for research papers published in the field. It is evident that conducting interviews with industry professionals would validate the literature review findings of this paper.

REFERENCES

Yates, D. (1998). Conflict and Dispute in the Development Process: A Transaction Cost Economics Perspective, http://business2.unisa.edu.au/prres/Proceedings/Proceedings1998/Papers/Yates3Ai.PDF

Otoo, J (2010), The Use of Animation in the Resolution of Construction Disputes, W113, Special Track 18th CIB World Building Congress, May 2010 Salford, United Kingdom

Tan, S. (2010). Alternative dispute resolution in civil justice. In: Proceedings of W113 – Special Track 18th CIB World Building Conference, 2010. United Kingdom: World Building Conference. p. 147–159.

Koppinen, Tiina, Skanska Oy, Finland; Kiviniemi, Arto (2008). Putting the Client in the Back Seat - Philosophy of the BIM Guidelines, Proceedings of Joint CIB Conference: Performance and Knowledge Management, Rotterdam (Netherlands)

Safe Work Australia (2017), Construction Industry Profile, https://www.safeworkaustralia.gov.au/doc/construction-industry-profile

Zhang, S., Teizer, J., Lee, J.-K., Eastman, C. M., & Venugopal, M. (2013). Building Information Modeling (BIM) and Safety: Automatic Safety Checking of Construction Models and Schedules. Automation in Construction, 29, 183-195. doi:https://doi.org/10.1016/j.autcon.2012.05.006

Hergunsel, M. F. (2011). Benefits of Building Information Modeling for Construction Managers and BIM Based Scheduling, Master thesis, Worcester Polytechnic Institute

Azhar, S., Nadeem, A., Y N Mok, j., & H Y Leung, B. (2008). *Building Information Modeling (BIM): A New Paradigm for Visual Interactive Modeling and Simulation for Construction Projects*.

Linderoth, H., Johansson, P., & Granath, K. (2014). The role of bim in preventing design errors. Paper presented at the 30th Annual ARCOM Conference, 1-3 September 2014, Portsmouth, UK. http://urn.kb.se/resolve?urn=urn:nbn:se:hj:diva-24740

Hijazi, W., Alkass P, S., Tarek, & Zayed, T. (2009). Constructability assessment using BIM/4D CAD simulation model.

Strafaci, A (2008). What does BIM mean for civil engineers? Road and highway projects can benefit from design using building information modeling. CE News October 2008,

Jan Tulke and Jochen Hanff (2007). 4D construction sequence planning – new process and data model, Proceedings of CIB-W78 24 th International Conference on Information Technology in Construction, pp. 79—84

Sacks, R., Treckmann, M., & Rozenfeld, O. (2009). Visualization of Work Flow to Support Lean Construction. *Journal of construction engineering and management, 135*(12), 1307-1315. doi:doi:10.1061/(ASCE)CO.1943-7862.0000102

Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. *Leadership and Management in Engineering, 11*(3), 241-252. doi:10.1061/(ASCE)LM.1943-5630.0000127

Gill, A., Gray, J., Skitmore, M., & Callaghan, S. (2015). Comparison of the effects of litigation and ADR in South-East Queensland. International Journal of Construction Management, 15(3), 254-263. doi:10.1080/15623599.2015.1066568

TOWARDS DIVERSE HOUSING WITH BETTER LIVEABILITY: TWO POSTGRADUATE DESIGN STUDIOS IN MELBOURNE

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Abstract
From the 1960s to the early 1970s, a number of social housing projects were completed in Victoria with the erection of forty-five residential blocks having twelve storeys or above. This paper discusses the shortcomings of those social housing estates, including building typologies, ground floor spatial utilisation and building frontages for street vitality. To address the issues, two postgraduate architectural design studios titled: "Living Proof: Liveability Award for Social Prahran" and "Home @ Atherton Garden" were delivered in 2016 by using the social housing estates in Prahran and Fitzroy as case studies. The research themes of these studios included the design of hybrid-use precincts for enhanced liveability, well-connected walkable community for health and wellbeing of residents, as well as the integration of social housing into surrounding neighbourhoods to avoid social stigmatisation. Postgraduate design studios can be regarded as a creative laboratory for testing ideas through field observations, site analysis, engagement with different stakeholders and active collaboration among students. Ideas generated from design studios can facilitate the ongoing exploration for alternative approaches and future directions for modelling diverse housing with better liveability.

Keywords: Housing design; Liveability; Walkability; Connectivity; Neighbourhood; Mixed-use.

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INTRODUCTION

From the 1960s to the early 1970s, the Housing Commission in Victoria launched a series of social housing projects. A total of forty-five residential blocks with twelve storeys or above were erected, including the two 12-storey Y-blocks of the Horace Petty Estate in Prahran and the four 20-storey residential blocks of the Atherton Gardens in Fitzroy. However, there are many shortcomings of these housing estates.

As shown by both Horace Petty Estate and Atherton Gardens (Figure 1), the *tabula rasa* development approach was adopted, which was influenced by the modernist view of Le Corbusier's 'A City of Towers' in *Towards a New Architecture* (1931). Rationalisation and functionalism were promoted through the erection of tall residential towers. However, after site clearance and imposition of tall residential towers, the housing estates do not stitch well with the surrounding context and the adjacent fine grain urban fabric. Both estates are even surrounded by boundary fencing (Figure 2) which significantly affect the connectivity and walkability of the site, resulting in isolated and deserted open spaces segregated from public access. Although large open spaces are provided in these two estates, they are under-utilised and poorly connected due to the lack of programs and are overshadowed by the tall residential blocks (Figure 1).

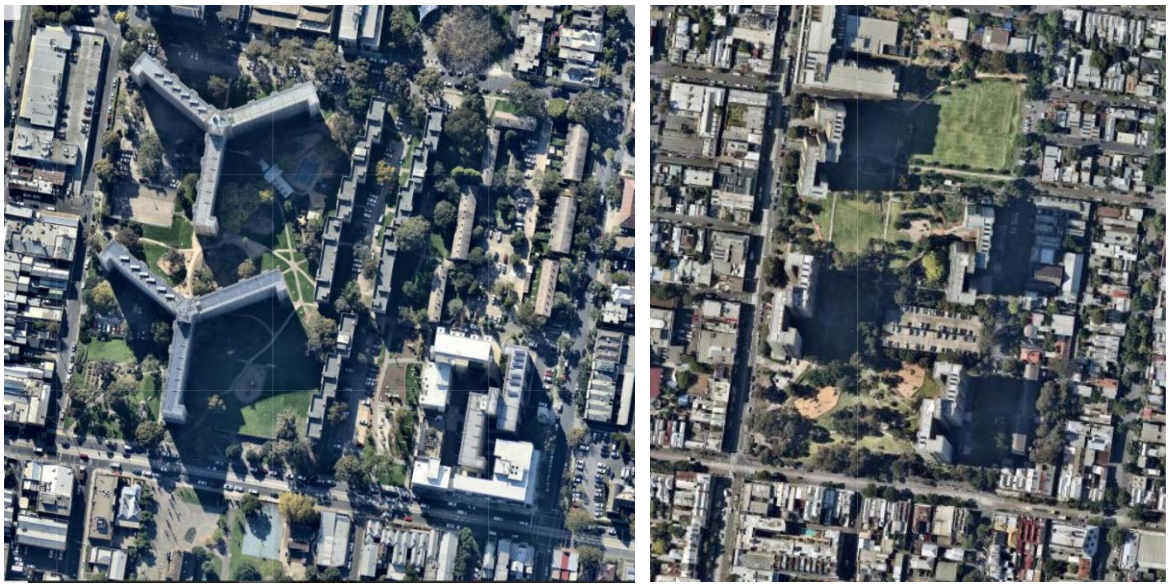

Figure 1: Overshadowing at Horace Petty Estate (left) and Atherton Gardens (right)

Figure 2: Boundary fencing at Horace Petty Estate (left) and Atherton Gardens (right)

In view of the fact that the housing estates are residential in nature accommodating low-income vulnerable people, the spatial isolation from the surrounding neighbourhood contributes to their social stigmatisation. Another issue is the lack of active street building frontages. The ground floors of the residential blocks are mostly vacant affecting the usage of adjacent open spaces and street vitality (Figure 3).

The layouts of residential blocks are based on single-loaded corridors. The linear configuration of corridors does not facilitate social interaction among residents. The direct emission of oily gas from kitchen exhaust fans brings annoying smells to the circulation space and causes an obvious layer of grease on corridor windows which affects the views and visibility (Figure 3).

Figure 3: Horace Petty Estate: Lack of program for ground level activation (left),
Atherton Gardens: Linear corridor (middle) and a layer of grease on corridor windows due to emission of oily gas from kitchen exhaust fans (right)

POSTGRADUATE DESIGN STUDIOS

In view of the above-mentioned shortcomings, a postgraduate architectural design studio titled 'Living Proof: Liveability Award for Social Prahran' was organised at the Melbourne School of Design, the University of Melbourne in the first semester of 2016 using the Horace Petty Estate as the site for investigation, followed by the subsequent studio titled 'Home@Atherton Gardens, Fitzory' in the second semester of 2016. A design studio is a place of experimentation and exploration. Through site visits and the engagement with different stakeholders, including government officers and practising design practitioners, students were encouraged to explore site potential, carry out site analysis, prepare group master plans and examine building typologies towards their final individual presentations. The learning process is problem driven and project oriented, which enables students to have the freedom to identify which key issues and objectives they want to address. This triggers students' motivation to be actively involved throughout the whole design process. In these studios, students explored various design directions, including mixed use, diverse building typology, enhanced accessibility and connectivity, better walkability with human scale, as well as the provision of communal spaces and the sense of neighbourhood.

MIXED USE

In order to activate the site, a mixed-use precinct is important for bringing people for work and creating opportunities for social interaction (Figure 4). In view of the low-income residents living in social housing, affordable retail and office spaces are crucial for encouraging social enterprises and small businesses to cater for the needs of the residents. Through training and employment programs, social enterprises can provide services to disadvantaged groups, who may otherwise be exposed to impacts of gentrification and be socially isolated from the surroundings (Borzaga and Defourny 2004). Communal facilities for different aged groups, including children, teenagers, university students, young couples, retirees and older adults, can be woven together through the fabric of the precinct to support the social participation and involvement of residents and the wider community towards a multi-generational living environment.

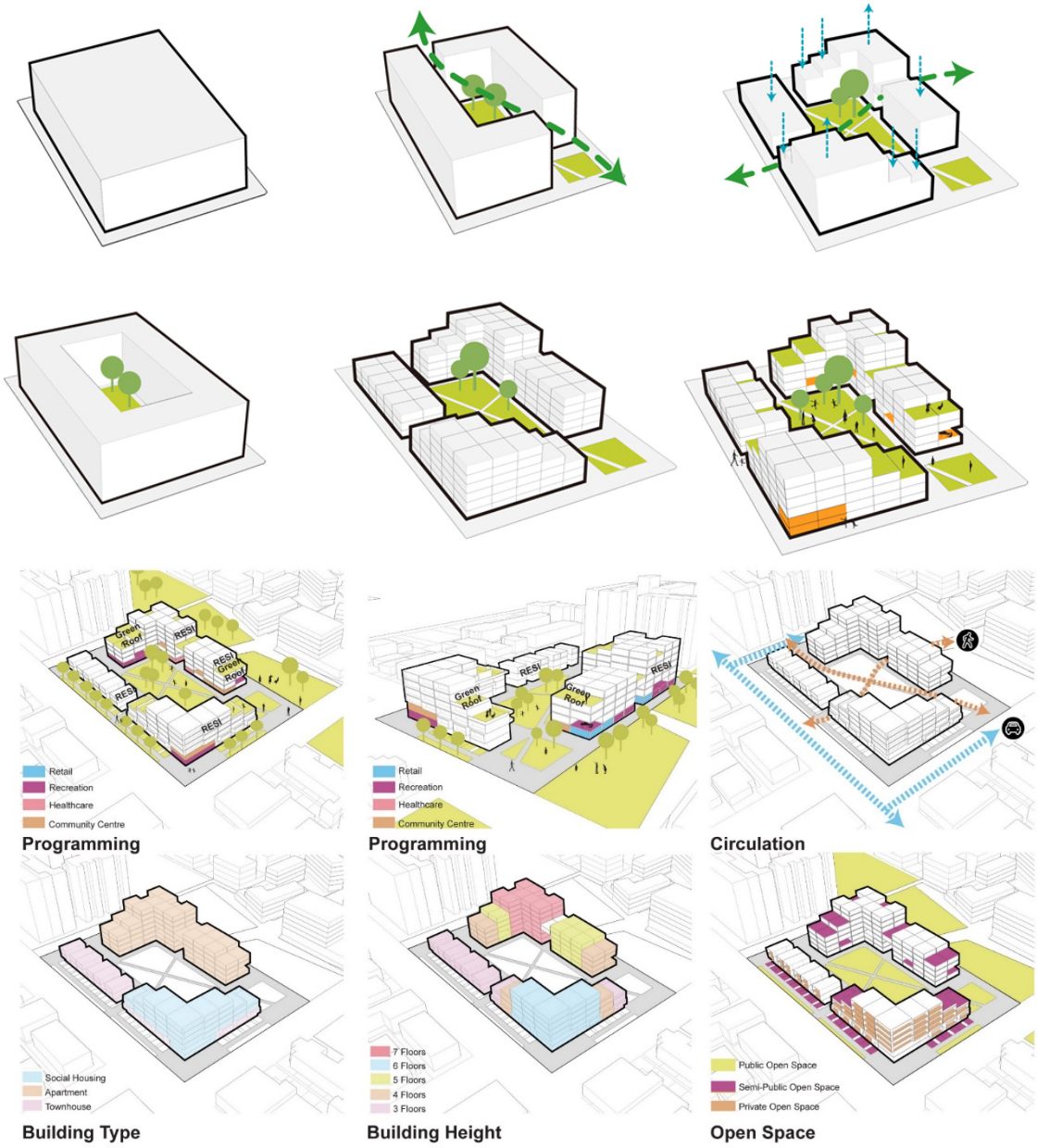

Figure 4: Mixed-use precinct for a multi-generational living environment

DIVERSE BUILDING TYPOLOGY

Diverse building typologies for providing a range of housing types, including affordable and social housing, can enhance social mix and eliminate stigma associated with disadvantaged low-income groups (Holmqvist and Bergsten 2009). The mix of well-designed buildings in a precinct blends social housing with other owner-occupied properties. Due to the high waiting lists for social housing in Victoria, no net loss of social housing stock should be ensured during redevelopment (DHHS 2016). For a more inclusive community, other housing options, such as student accommodation and retirement apartments, can also be provided to avoid any particular social group being segregated (Sautkina, Bond and Kearns 2012). The blend of different socio-economic groups can facilitate the establishment of a dynamic and vibrant community. Ground floor of buildings, especially those facing surrounding streets, can be utilised for different programs to activate frontages for street vitality (Figure 5).

Figure 5: Diverse building typologies with active street frontage to avoid social stigmatisation

ENHANCED ACCESSIBILITY AND CONNECTIVITY

The site boundaries of the precinct should be permeable and blurred with surrounding areas. Contrary to the current situation of both Horace Petty Estate and Atherton Gardens being isolated and surrounded by boundary fencing, the development direction should aim to improve the integration of the site with existing urban fabric (Figure 6). Besides having activate street frontages to encourage social interaction along the periphery, better permeability enables residents and the wider public to access to community facilities within the site (Larco, Kelsey and West 2014).

Figure 6: Accessibility and connectivity of the precinct with the surrounding urban fabric

BETTER WALKABILITY WITH HUMAN SCALE

Thoroughfares that currently stop at the boundaries of the Horace Petty Estate and Atherton Gardens can be reconnected to facilitate residents and the wider community to walk through the site. For an inclusive community environment, high quality pedestrian environments should be provided which can allow footpath-bound vehicles, such as wheelchairs, prams and scooters to access (Figure 7). The human scale and natural surveillance of the open realm can further enhance the safety of public circulation spaces which are much easier to navigate both day and night according to the principles of Crime Prevention through Environmental Design (CPTED) (Crowe 2013).

Figure 7: Walkability within the precinct through human-scaled green space networks

PROVISION OF COMMUNAL SPACES AND SENSE OF NEIGHBOURHOOD

For creating a liveable community, a variety of communal spaces should be provided to activate the life between buildings and foster the sense of neighbourhood (Gehl 2011). Communal spaces include courtyards, parks, laneways and footpaths. The enjoyment of these public realms is enhanced by a desirable balance of sunlight and shade, which should not be compromised by overshadowing or too much sun exposure. Apart from having communal areas on ground floor, a range of shared outdoor spaces can also be provided at various levels, including podium terraces and roof gardens, which can facilitate people of all ages to gather and support social interaction, such as having shared garden beds and greenhouses for connecting the community through gardening, sustainability and educational activities (Figure 8).

Figure 8: A variety of communal spaces to foster the sense of neighbourhood

CONCLUSIONS

Through these two postgraduate studios, various design options were proposed for diverse housing and better liveability. The redevelopment of both Horace Petty Estate and Atherton Gardens has been discussed and explored by the local government, so these two studios was timely to explore alternative development directions in terms of mixed use, diverse building typology, enhanced accessibility and connectivity, better walkability with human scale, as well as the provision of communal spaces and the sense of neighbourhood.

By using real-world issues, these studios drew students' attention of the importance of a well-designed living environment which could foster a vibrant community and cater for the needs of different aged groups. Students could be more aware of the prevailing social problems, which could equip themselves the capabilities to formulate corresponding strategies to cope with the ever faster changing professional environment.

ACKNOWLEDGEMENT

The author acknowledges the faculty support provided by the University of Melbourne for organising these two postgraduate architectural design studios and the active engagement of students. Drawings prepared by some students are shown in this paper: Figure 4 by Xiaofei Liang, Figure 5 by Weijia Pan, Figure 6 by Tiange Li and Penghong Lu, Figure 7 by Timothy Farrugia and Yanbo Lin, and Figure 8 by Weijia Pan.

REFERENCES

Borzaga, C. and Defourny, J. (2001) *The emergence of social enterprise.* Routledge, London; New York.

Crowe, T. D. (2013) *Crime Prevention through Environmental Design.* Elsevier, Amsterdam.

DHHS (Department of Health and Human Services) (2016) Social housing. Available online: http://www.housing.vic.gov.au/social-housing (accessed on 8 May 2018).

Gehl, J. (2011) *Life between Buildings: Using Public Space.* Island Press, Washington.

Holmqvist, E. and Bergsten, Z. (2009) Swedish social mix policy: a general policy without an explicit ethnic focus. *Journal of Housing and the Built Environment*, 24(4), 477-490.

Larco, N., Kelsey, K. and West, A. *Site Design for Multifamily Housing: Creating Liveable, Connected Neighbourhoods.* Island Press, Washington.

Le Corbusier (1986) *Towards a new architecture* (1931). Dover Publications, New York.

Sautkina, E., Bond, L. and Kearns, A. (2012) Mixed evidence on mixed tenure effects: Findings from a systematic review of UK studies, 1995-2009. *Housing Studies*, 27(6), 748-782.

Melis, G., Marra, G. and Gelormino, E. (2013) Equity Action Work Package 6: Literature Review – Housing and Social Mix. Available online: https://www.researchgate.net/profile/Giulia_Melis/publication/282712940_Are_social_mix_policies_effective_in_reducing_residential_segregation_and_health_inequalities_Results_from_a_literature_review/links/565c2a2408ae4988a7bb62e2.pdf (accessed on 4 May 2018).

BUILDING'S LIFE CYCLE EMBODIED CARBON EMISSIONS ASSESSMENTS: A REVIEW

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Abstract: The building industry has long been criticised with significantly consuming natural resources and discharging high volumes of greenhouse gas emissions. It is therewith critical for the entire industry to work towards sustainable design and 'green' construction with which the environmental impacts could be greatly reduced. Overall, buildings' life cycle emissions comprise of those at the construction stage (embodied carbon), and those at the operation stage. While a massive effort has been put into curbing operational emissions, embodied emissions occurring in the upstream processes are largely overlooked. Since recent studies have increasingly emphasised the importance of embodied carbon and presented many quantification analysis studies, the contemporary state of research is plagued by a wide variation of embodied carbon values. This therefore prompts to an overview of three common Life Cycle Assessment (LCA) approaches, which are process, input-output and hybrid analyses. Especially, several restrictions in applying LCA studies throughout the building's life cycle are also discussed. Finally, the authors urge that it is vital to develop a robust inventory data and a comprehensive methodology to streamline the embodied emissions computation framework and recommend that future research should focus on holistic carbon assessment standard that could calibrate both embodied and operational carbon impacts.

Keywords: Buildings; Embodied emissions; Life Cycle Assessment (LCA); Process analysis; Input-output analysis; Hybrid analysis

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INTRODUCTION

The building and construction sector is crucial as it serves as a lifeblood of the economy. Such a sector, which is heavily tied to natural resources and waste generation, has been long plagued as the single largest contributor to climate change (Gong et al., 2012). In the Europe Union, the built environment consumes 50% of the raw materials, 42% of the energy consumption, and releases 35% of greenhouse gas emissions (GHG) along with 32% of waste flows (Pomponi & Moncaster, 2016). Moreover, the annual usage of concrete in the construction industry continues to increase to 23 billion tons (Miller, Doh, & Mulvey, 2015), and the cement industry solely contributes 5% to the global CO_2 emissions (Flower & Sanjayan, 2007). It is therefore urgent for the construction sector to formulate effective solutions and techniques to accommodate sustainable development strategies.

Basically, the building's lifecycle carbon emissions consist of two main components: embodied and operational emissions. Due to the largest share of energy-related operational emissions, embodied carbon is presently not a consideration when the building is designed, specified and constructed (Alwan & Jones, 2014). However, recently, there has been solid evidence that embodied impacts also serve as the main contributor to the global emissions. Based on structural types and functions of buildings, geographic and climatic conditions, applied construction methods, and so forth, embodied emissions can occupy more than 50% (R. Crawford, 2011) and up to 74-100% (Chastas, Theodosiou, & Bikas, 2016) of the building's lifecycle carbon emissions. Further, Ibn-Mohammed, Greenough, Taylor, Ozawa-Meida, and Acquaye (2013) identified that the increasing proportion of embodied impacts was, in fact, one consequence of efforts to minimise the operational emissions, thereby shifting the environmental pressures from one stage to the others. This implies that there is a certain limit for the overall emission savings through reduction in operational energy; thus, sustainable design now should target towards the impacts embodied in the remaining phases of the building's life cycle.

Despite the growing awareness and development of computation models, there is currently no globally-accepted analysis framework and design standard that cover the embodied environmental impacts in the building performance assessment. As a great amount of quantification analyses were derived for estimating embodied carbon of different buildings' types, a wide range of findings were found in the body knowledge. According to Eaton and Amato (1998), the embodied emissions of different structures—namely steel, composite, reinforced and precast concrete—was in the range of 600-850 $kgCO_2$-eq/m^2. On the other hand, Clark (2013) reported that the embodied carbon value of office buildings varied from 300 to 1650 $kgCO_2$-eq/m^2, relying on divergent methodologies applied in academic and industry assessments (De Wolf, Pomponi, & Moncaster, 2017). Recently, Manish K Dixit, Fernández-Solís, Lavy, and Culp (2012) reported several parameters causing the variability of embodied impact values, which were system boundaries, measurement methods, the building's geographic location, data resources' ages and completeness, technology of manufacturing processes, and so forth. Hence, the authors emphasised the urgent need of a holistic and internationally-accepted measurement protocol to evaluate the embodied environmental impacts throughout a building's lifecycle.

At present, LCA reveals as a the most effective approach to quantify and evaluate the environmental impacts of a product/service, including associated emissions and cumulative energy consumption (Buyle, Braet, & Audenaert, 2013; Manish K Dixit et al., 2012). Therefore, this paper aims to provide a comprehensive overview of the building's lifecycle embodied carbon emissions assessments that rigorously elaborates their advantages and restrictions. Further, the paper discusses several difficulties in applying

LCA concept in the context of a building and emphasises the need for an internationally-accepted assessment framework to calibrate both embodied and operational carbon in the building sustainability analysis.

BUILDING'S LIFE CYCLE CARBON EMISSIONS

The life cycle carbon emissions can be categorised into Embodied Carbon (EC) and Operational Carbon (OC). While EC is defined as the carbon emitted from the extraction, manufacturing, transportation of the final material to onsite assembly, OC is the carbon expended to maintain the desired indoor environment of a building, encompassing all activities relevant to the function of the building, including HVAC system, domestic hot water, lighting and appliances (Akbarnezhad & Xiao, 2017). However, in practice, there are various definitions of EC, relying on the boundary of the studies and EC's different forms. Based on the chosen system boundary, there are three common definitions: cradle-to-gate; cradle-to-site; and cradle-to-grave EC (Figure 1).

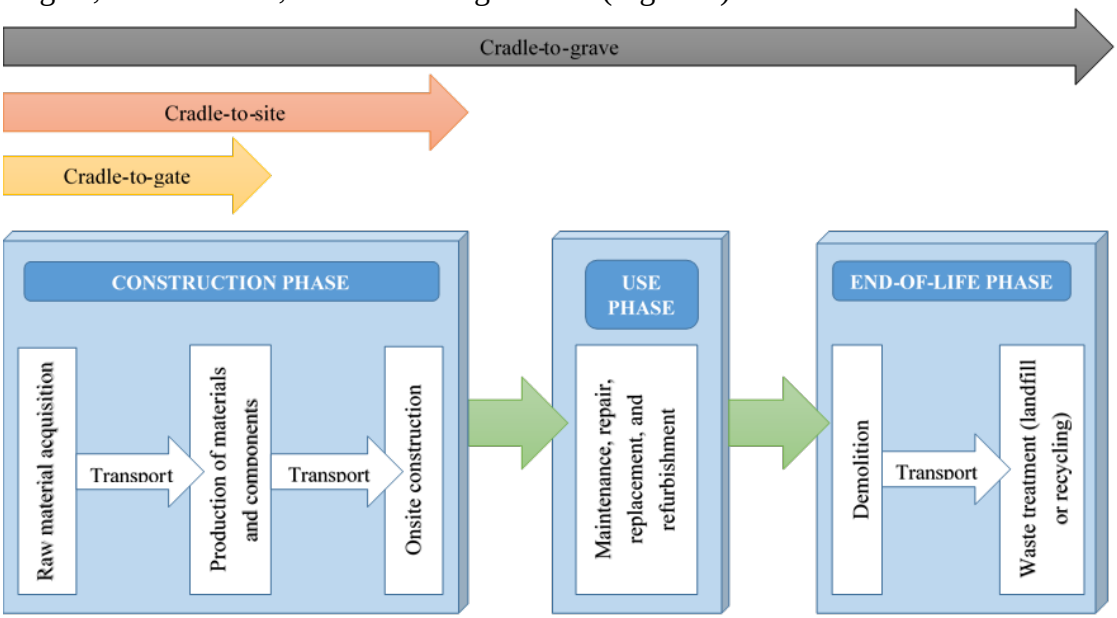

Figure 1. Building's lifecycle EC emissions (Trinh, Doh, & Lei, 2017).

According Li, Yang, Zhu, and Gao (2014), EC composes of two forms: direct emissions from the assembly activities and indirect emissions incurred in the extraction of feedstock, and the production and transportation of final building materials to the construction site. Further, EC can be defined as the summation of fuel-related carbon emissions, discharged from the production plants and equipment, and process-related carbon emissions, for example, the calcination of limestone occurring in the cement manufacture (Moncaster & Symons, 2013). Moreover, in the same manner of Embodied Energy (EE), embodied emissions can also be classified into: Initial Embodied Emissions, ranging from the material production to the jobsite erection phase and Recurring Embodied Emissions, referring to repair and replacement when the material's lifespan is shorter than the building operation years (Ramesh, Prakash, & Shukla, 2010). Besides, to obtain the most accurate figure of a building's lifetime EC emissions, the sequestration of carbon in constructive materials (such as timber and wood components) and the lifetime use of materials (such as the carbonation of concrete) should also be considered (Collins, 2010; Moncaster & Symons, 2013).

LIFECYCLE CARBON EMISSIONS ASSESSMENT

LCA is an approach focusing on appraising the total environmental burden associated with a product, process or service throughout its lifetime expectancy (Khasreen, Banfill, & Menzies, 2009). By identifying energy and material inputs and quantifying environmental loadings, namely carbon emissions and solid/liquid waste, the model is capable of evaluating the ecological performance of the assessed system and assisting the implementation of improving strategies (Chau, Leung, & Ng, 2015). Typically, the assessment encompasses the whole lifecycle of the product, including upstream supply-chain (extraction and production of materials, transportation, distribution and construction), use (operation and maintenance), and downstream processes (demolition, waste disposal and recycling). Based on geographical features of the system's location, critical environmental impacts, such as climate change, terrestrial acidification, ozone depletion, marine/freshwater eutrophication, are computed, by means of energy and resource consumption and waste generation. According to ISO 14040:2006, LCA is comprised of four phases: Goal and Scope Definition, Inventory Analysis, Impact Assessment and Interpretation. Specifically, the first phase is to select the functional units and system boundaries, which are appropriate for the main objectives, the comparability and reproducibility of the appraisal. Then, all data pertaining to inputs, processes, and emissions are inventoried in Phase 2, and utilised to calculate input resources and the corresponding environmental impact in Phase 3. Finally, the obtained results are interpreted to make recommendations for areas requiring improvement.

There are two distinct variants of LCA with the Life Cycle Energy Assessment (LCEA), targeting energy consumption, and the Life Cycle Carbon Emissions Assessment (LCCO2A), concentrating on the carbon emissions discharged (Chau et al., 2015). Despite its great importance in the evaluation of a system's environmental behaviour, the latter stream of LCA studies (LCCO2A) receives less attention than the former one (Pomponi & Moncaster, 2016). The LCCO2A was possibly derived in response to the extreme consequences of global warming. Since the Kyoto Protocol took effect in 2005, many studies have been conducted to evaluate the carbon emissions released from buildings. Not only does the Kyoto Protocol define six main GHGs, the impact of all GHG emissions is also normalized by their relative warming effect with respect to CO_2, the so-called 'global warming potential' (GWP) in terms of CO_2-equivalent, to enhance comparability and the reporting process of the overall global warming impact (Akbarnezhad & Xiao, 2017). Figure 2 illustrates the basic concepts of LCA and how the LCEA and LCCO2A interact over the lifecycle stages.

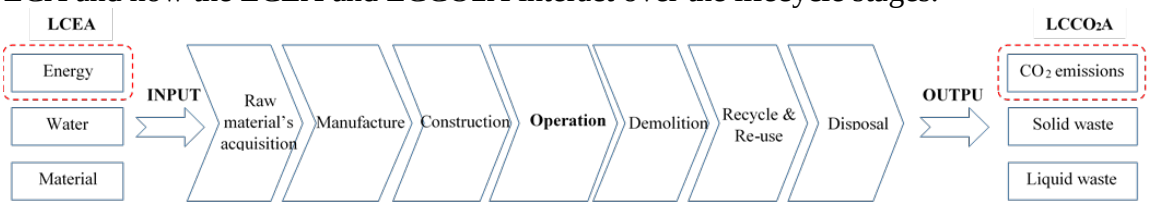

Figure 2. Conceptual diagram of LCA (adopted from (Chau et al., 2015))

EMBODIED CARBON DETERMINATION METHODOLOGIES

LCA is reported as a widely adopted methodology to quantify and evaluate the environmental impact of a product/service, including the associated emissions and cumulative energy consumption (Buyle et al., 2013; Manish K Dixit et al., 2012). According to Manish Kumar Dixit, Fernández-Solís, Lavy, and Culp (2010), the primary LCA determination methods could be categorized into statistical analysis, process analysis, economic input-output (I-O) analysis and hybrid analysis. Despite the specific

and reliable evaluation outcomes, statistical analysis is applied in a limited fashion due to its high dependence on comprehensive published statistics, which are rarely collected in most countries (Mao, Shen, Shen, & Tang, 2013)

Process analysis

In contrast to statistical analysis, process-based analysis (the bottom-up method) is preferably utilised. Process analysis traces all materials and energy flows in the manufacturing chains, using a process flow diagram, and estimates the corresponding environmental effects (Guggemos & Horvath, 2006; Mao et al., 2013). According to Sharrard, Matthews, and Ries (2008), owing to the complex nature of the construction industry, the better apprehension of environmental implications would be best achieved by process LCA. Although the results are detailed and process-specific, allowing for the comparability of products/processes and the identification of required improvement areas, process LCA is time-consuming, costly and labour-intensive, owing to various activities involved in the production process (Atmaca & Atmaca, 2015). To tackle this issue, an appropriate system boundary is established to monitor all physical flows and the data collection. However, the selected boundary conditions could be subjective and incomplete, leading to systematic truncation errors that reduce the final outcomes by 50% compared to other approaches (R. H. Crawford, 2008). According to Nässén, Holmberg, Wadeskog, and Nyman (2007), process analysis showed 90% lower specific energy use compared to I-O analysis and tended to underestimate the energy consumption of transportation, construction works, machinery production, and service sectors.

I-O analysis

Economic I-O analysis (top-down approach) encompasses all services within a complete system boundary, through an analysis of environmental inputs and outputs from associated industry sectors (Moncaster & Symons, 2013). Particularly, I-O transaction tables, depicting the purchase flows between economic sectors and their corresponding added value, are utilised to allocate the environmental output of each sector to the appraised system through monetary data. The competence of this method lies in the accountability of all indirect impacts embodied in the upstream chains, which is impossible to completely cover by process analysis (Yan, Shen, Fan, Wang, & Zhang, 2010). Specially, it is best suited for the computation of the overall energy consumption and carbon emissions of the construction sector and the average environmental intensity of all buildings (Nässén et al., 2007; Shao et al., 2014).

Nevertheless, I-O analysis is also subject to many drawbacks and limitations. For instance, I-O LCA cannot sufficiently account for project-specific differences, thereby being unable to enhance comparison among different buildings (Akbarnezhad & Xiao, 2017; Shao et al., 2014). Due to product aggregation in sectors, the carbon intensity of a certain sector can be either underestimated or overestimated depending on its weighting in the sector combination. Moreover, I-O analysis assumes the national average environmental intensities for all products produced by a particular sector, resulting in homogeneity error (R. Crawford, 2011). Further, it equates carbon emissions directly with monetary values, therefore usually hiding the carbon benefits of ‘green’ materials with relatively high prices (Moncaster & Symons, 2013) and distorting physical flow relationship amongst industries due to price inhomogeneity (Suh et al., 2004). Other shortcomings such as difficulty in handling of imports, and double counting in energy supply sectors are also identified and addressed (Akbarnezhad & Xiao, 2017; Atmaca & Atmaca, 2015; Nässén et al., 2007; Omar, Doh, Panuwatwanich, & Miller, 2014).

Hybrid analysis

Regarding the benefits and shortcomings of process and I-O analysis, Bullard et al. (1978) were the first to incorporate the more detailed process LCA and the extended system boundary of I-O LCA into a so-called hybrid analysis (Suh et al., 2004). In general, hybrid approaches can be classified into three categories: tiered hybrid analysis; input/output-based hybrid analysis; and integrated hybrid analysis (Suh et al., 2004; Treloar, 1998). Overall, with hybrid LCA (HLCA), both upstream and downstream processes of product manufacture can be adequately analysed by further considering direct and indirect emissions. Thus, HLCA can handle cutoff errors, the level of aggregation in sectors, and temporal and geographic uncertainties (Omar et al., 2014). In detail, HLCA combines the more specific process LCA data into I-O LCA framework to diminish the truncation errors and aggregation uncertainty. On the other hand, by employing the national economic I-O table, which is commonly issued every five years by the Bureau of Statistics, hybrid LCA can effectively manage temporal and geographic uncertainties. Although hybrid analysis is notorious for its data and time-intensive requirements, I-O-based hybrid LCA developed by Treloar (1997) is believed to be the most complete and comprehensive environmental analysis of a building performance (R. H. Crawford, 2010). In addition, HLCA can be employed in case of unavailability of process data and resources (Suh et al., 2004).

Difficulties in EC assessment

In the context of a building, employing LCA for lifecycle EC assessments is not directly straightforward for many reasons. Firstly, buildings are varied in size, form and function. They are complicated and one-of-a-kind in nature; therefore, the erection usually involves the assemblage of various materials and components (Manish K Dixit et al., 2012). Also, building material production is less standardized owing to the unique features of each building, thereby limiting the environmental evaluation of the manufacture of materials, construction and demolishment processes (Ramesh et al., 2010). Secondly, the materials and products exploited may possess a wide range of environmental impacts in their manufacture, which is hard to trace due to the non-uniformity of the system boundary (Manish K Dixit et al., 2012). Additionally, the assessment of buildings requires site-specific data to cover spatial differences. Since data availability during the early design phases is very limited, several data resources and assumptions are leveraged, resulting in inaccuracies. Thirdly, the technology pertaining to material production and construction is developing rapidly, which significantly changes the related embodied impacts. Hence, there is always a shortage of inventory data for some innovative or 'green' materials, hindering the comparison against conventional materials (Chau et al., 2015).

Fourthly, since a building has a much greater service life than normal products, tracking and appraising for such a long time require massive effort in terms of data collection and interpretation. More so, during its functional life, buildings may experience changes due to their dynamic characteristics, such as function alteration, retrofit and renovation, and repair/replacement activity, further complicating the data-collecting process (Khasreen et al., 2009). Besides, the lifespan of a building is difficult to determine since both the service life and the adaptability of the building to the market demand should be considered (Peng, 2016). Therefore, LCA studies in fact do not consider time-dependent aspects and usually assume constant impacts over the building's lifetime (Chau et al., 2015). Fifthly, the delivery process of a building is influenced by diverse behaviours and motivations of key stakeholders, worsening the complex issue (Ibn-Mohammed et al., 2013). Finally, according to Chau et al. (2015), in practice, the lack of benchmarks in building performance studies and chain management responsibility, and the non-

commitment of top-level management to LCA could be fundamental barriers for LCA application. In summary, these forgoing factors challenge the environmental assessment of the building industry.

CONCLUSION

To conclude, this research elaborates three typical LCA quantitative methodologies and their limitations for EC calculation. Numerous barriers in applying LCA studies in lifecycle carbon emissions assessment are discussed, such as the unique and complex nature of buildings, the lack of international protocols and inventory data, the non-commitment of top-level management to sustainability, and the limitations in quantitative approaches'. As there are several definitions and quantification analysis studies of embodied emissions, the contemporary state of research is plagued by a wide variation of EC values. Due to the increasingly recognised significance of EC and the current trend towards low-carbon buildings, it is crucial to develop a robust inventory data and a comprehensive methodology to streamline the EC computation framework. Moreover, the development of a lifetime carbon accounting benchmark in terms of both embodied and operational carbon is in high demand to provide the trade-offs within different design options; and therefore, a better understanding of the potential of GHG mitigation strategies.

REFERENCES

Akbarnezhad, A., & Xiao, J. (2017). Estimation and Minimization of Embodied Carbon of Buildings: A Review. *Buildings, 7*(1), 5.

Alwan, Z., & Jones, P. (2014). The importance of embodied energy in carbon footprint assessment. *Structural Survey, 32*(1), 49-60.

Atmaca, A., & Atmaca, N. (2015). Life cycle energy (LCEA) and carbon dioxide emissions (LCCO 2 A) assessment of two residential buildings in Gaziantep, Turkey. *Energy and Buildings, 102*, 417-431.

Buyle, M., Braet, J., & Audenaert, A. (2013). Life cycle assessment in the construction sector: A review. *Renewable and Sustainable Energy Reviews, 26*, 379-388.

Chastas, P., Theodosiou, T., & Bikas, D. (2016). Embodied energy in residential buildings-towards the nearly zero energy building: A literature review. *Building and Environment, 105*, 267-282.

Chau, C. K., Leung, T. M., & Ng, W. Y. (2015). A review on Life Cycle Assessment, Life Cycle Energy Assessment and Life Cycle Carbon Emissions Assessment on buildings. *Applied Energy, 143*, 395-413.

Collins, F. (2010). Inclusion of carbonation during the life cycle of built and recycled concrete: influence on their carbon footprint. *The international Journal of life cycle assessment, 15*(6), 549-556.

Crawford, R. (2011). *Life cycle assessment in the built environment*: Taylor & Francis.

Crawford, R. H. (2008). Validation of a hybrid life-cycle inventory analysis method. *Journal of environmental management, 88*(3), 496-506.

Crawford, R. H. (2010). *Zero-emissions housing: the great impossible Australian dream.* Paper presented at the 44th Annual Conference of the Architectural Science Association, ANZAScA.

De Wolf, C., Pomponi, F., & Moncaster, A. (2017). Measuring embodied carbon dioxide equivalent of buildings: A review and critique of current industry practice. *Energy and Buildings, 140*, 68-80.

Dixit, M. K., Fernández-Solís, J. L., Lavy, S., & Culp, C. H. (2010). Identification of parameters for embodied energy measurement: A literature review. *Energy and Buildings, 42*(8), 1238-1247.

Dixit, M. K., Fernández-Solís, J. L., Lavy, S., & Culp, C. H. (2012). Need for an embodied energy measurement protocol for buildings: A review paper. *Renewable and Sustainable Energy Reviews, 16*(6), 3730-3743.

Eaton, K., & Amato, A. (1998). A comparative life cycle assessment of steel and concrete framed office buildings. *Journal of constructional steel research, 1*(46), 286-287.

Flower, D. J., & Sanjayan, J. G. (2007). Green house gas emissions due to concrete manufacture. *The international Journal of life cycle assessment, 12*(5), 282.

Gong, X., Nie, Z., Wang, Z., Cui, S., Gao, F., & Zuo, T. (2012). Life cycle energy consumption and carbon dioxide emission of residential building designs in Beijing. *Journal of Industrial Ecology, 16*(4), 576-587.

Guggemos, A. A., & Horvath, A. (2006). Decision-support tool for assessing the environmental effects of constructing commercial buildings. *Journal of Architectural Engineering, 12*(4), 187-195.

Ibn-Mohammed, T., Greenough, R., Taylor, S., Ozawa-Meida, L., & Acquaye, A. (2013). Operational vs. embodied emissions in buildings—A review of current trends. *Energy and Buildings, 66*, 232-245.

International Organization for Standardization. (2006). *Environmental management--Life cycle assessment--Principles and framework* (14040).

Khasreen, M. M., Banfill, P. F., & Menzies, G. F. (2009). Life-cycle assessment and the environmental impact of buildings: a review. *Sustainability, 1*(3), 674-701.

Li, X., Yang, F., Zhu, Y., & Gao, Y. (2014). An assessment framework for analyzing the embodied carbon impacts of residential buildings in China. *Energy and Buildings, 85*, 400-409.

Mao, C., Shen, Q., Shen, L., & Tang, L. (2013). Comparative study of greenhouse gas emissions between off-site prefabrication and conventional construction methods: Two case studies of residential projects. *Energy and Buildings, 66*, 165-176.

Miller, D., Doh, J.-H., & Mulvey, M. (2015). Concrete slab comparison and embodied energy optimisation for alternate design and construction techniques. *Construction and Building Materials, 80*, 329-338.

Moncaster, A. M., & Symons, K. E. (2013). A method and tool for 'cradle to grave' embodied carbon and energy impacts of UK buildings in compliance with the new TC350 standards. *Energy and Buildings, 66*, 514-523.

Nässén, J., Holmberg, J., Wadeskog, A., & Nyman, M. (2007). Direct and indirect energy use and carbon emissions in the production phase of buildings: An input–output analysis. *Energy, 32*(9), 1593-1602.

Omar, W. M. S. W., Doh, J.-H., Panuwatwanich, K., & Miller, D. (2014). Assessment of the embodied carbon in precast concrete wall panels using a hybrid life cycle assessment approach in Malaysia. *Sustainable Cities and Society, 10*, 101-111.

Peng, C. (2016). Calculation of a building's life cycle carbon emissions based on Ecotect and building information modeling. *Journal of Cleaner Production, 112*, 453-465.

Pomponi, F., & Moncaster, A. (2016). Embodied carbon mitigation and reduction in the built environment–What does the evidence say? *Journal of environmental management, 181*, 687-700.

Ramesh, T., Prakash, R., & Shukla, K. (2010). Life cycle energy analysis of buildings: An overview. *Energy and Buildings, 42*(10), 1592-1600.

Shao, L., Chen, G., Chen, Z., Guo, S., Han, M., Zhang, B., . . . Ahmad, B. (2014). Systems accounting for energy consumption and carbon emission by building. *Communications in Nonlinear Science and Numerical Simulation, 19*(6), 1859-1873.

Sharrard, A. L., Matthews, H. S., & Ries, R. J. (2008). Estimating construction project environmental effects using an input-output-based hybrid life-cycle assessment model. *Journal of Infrastructure Systems, 14*(4), 327-336.

Suh, S., Lenzen, M., Treloar, G. J., Hondo, H., Horvath, A., Huppes, G., . . . Moriguchi, Y. (2004). System boundary selection in life-cycle inventories using hybrid approaches. *Environmental science & technology, 38*(3), 657-664.

Treloar, G. J. (1998). *Comprehensive embodied energy analysis framework.*

Trinh, T. M. K. H., Doh, J. H., & Lei, H. (2017). *An Overview of Building Lifecycle Embodied Carbon Emissions Research.* The proceedings of the 22nd International Conference on Advancement of Construction Management and Real Estate, Swinburne University of Technology.

Yan, H., Shen, Q., Fan, L. C. H., Wang, Y., & Zhang, L. (2010). Greenhouse gas emissions in building construction: A case study of One Peking in Hong Kong. *Building and Environment, 45*(4), 949-955.

SENSE OF COMMUNITY, COMMUNITY ATTACHMENT, SOCIAL CAPITAL AND PARTICIPATION IN URBAN HOUSING ESTATES: CASES OF COMMUNAL SPACE RENEWAL IN SHANGHAI

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Abstract
There are many researches discussing different dimensions of community development in different context, involving residents' participation and social capital, sense of community and neighborhood attachment, and changing meanings of community attachment in contemporary China's context. However, empirical analysis to examine contemporary China's community development in different housing estate types is understudied. It's especially meaningful to compare both distressed and prosperous housing estates, and to compare community development performance in certain type of housing estate which with and without communal space renewal. If this linkage could be established, it could provide guidance in using communal space renewal planning to improve community development in different housing estate types. This article aims to fill this gap by investigating the dynamics between sense of community, community attachment, social capital and participation through communal space improvement programs in three Shanghai urban housing estates types. Evidence presented in this paper, based on questionnaire with 720 residents in 12 housing estates and 36 interviews with relevant stakeholders. We found that communal space renewal and management could contribute to community development in its different aspects in different housing estate type context. Besides, this study still has implications for theoretical debates, community planning strategies and community development policy.

Key words: communal space renewal, housing estate type, sense of community, community attachment, social capital, Shanghai Model.

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INTRODUCTION

Community development is often regarded as an important local problem-solving approach (Craig, 1998), which emphasizes sustainable change in both urban and rural communities. In China, there is a growing trend in community concern within urban governance (Bray, 2006), China's community development and community governance become hot topics. Under the background of China's transformation (from a centrally planned economy to a social market economy), there is huge implication in government's ability to deliver public services (Derleth & Koldyk, 2004). There are many researches discussing different dimensions of community development in different context. Some focuses on the relations between political participation and social capital and neighborhood attachment (Hays and Kogl, 2007; Dekker, 2007), some emphasizes the willingness to stay in low-income community based on the discussion on neighborhood attachment and social participation (Wu, 2012), and some explores changing meanings of community attachment in contemporary China's Commodity Housing Estates (Zhu, Breitung, and Li, 2012). However, the research that examines social capital, attachment, participation and sense of community in different housing estate types is understudied, particularly under contemporary China's context of small-scale community renewal. This study attempts to explore and elaborate one of China's most noted examples of community development, so-called Shanghai Model, as the empirical case. This research aims to evaluate and explain community development, in particular, sense of community, social capital, community attachment, and community participation in different Shanghai housing estate types, by employing the case of communal space renewal and management. To fulfill the aim, there are two research questions: (1) to what extent could community communal space renewal influence sense of community, community attachment and community participation in different housing estate types; and (2) what factors could boost or constrain the role of communal space renewal in sense of community, social capital, community attachment and community participation. There are significances. First, this research provides a critical understanding of community development in Shanghai under its own political economy and urban contexts. Second, it provides empirical evidence on the communal space renewal and management in community development.

METHODS

Aiming to answer these questions, three steps are developed. First, selecting cases. Based on three criterions, 12 cases are selected: 4 Commodity Housing Estate, 4 Work-Unit Compound, and 4 Traditional Housing Estate. In each housing estate types, two are base cases, and two are comparison cases. Second step, 60 questionnaires were finished in each case, from March to May 2018. There were 720 questionnaires are collected. The questionnaire were not sent or mailed to the residents, but finished face-to-face, accompanied by short interviews to figure out reasons behind certain answers. For each case, 15 questionnaires were finished in the morning of workdays, 15 were in the afternoon of workdays, 15 in the morning of weekends, and 15 in the afternoon of weekends. Participants included both male and female, local and migrants, young people, the mid-aged and the elderly. Third step, 36 in-depth interviews were taken in total, covering leaders of Residents' Committee, leaders of Homeowners' Association, leaders of Property Management Company, staff in Street Office, and community planners. Apart from that, there were three professors who are engaged in community planning theory and practice, and two officers who work in Shanghai Planning and Land & Resource Management Authority. Apart from that, policies and regulations from government's websites and documents, information from bulletin and newsletter in Street Office and

Residents' Committee, reports and videos in public media and social media were all collected as supporting materials.

FINDINGS

The first finding was about the general comparison of in different housing estate types. The evaluation of sense of community and social capital in Traditional Housing Estates and Work-Unit Compounds were higher than in Commodity Housing Estates. The community attachment in Commodity Housing Estate was higher than other two types. While there were not many differences of community participation in the three housing estate types. The second finding was about the role of communal space renewal and management, based on the comparison sets (housing estates with and without the communal space renewal and management). Different housing estate types have different performances. In traditional housing estate with communal space renewal, community attachment, social capital, and community participation were increased, but sense of community did not show much differences. In particular, community attachment and social capital increased much higher than community participation. In Work-Unit Compounds with communal space renewal, social capital and sense of community did not increase much, but there were much higher community attachment and participation after the communal space renewal. In Commodity Housing Estates, not much increases in sense of community, but there were increasing in social capital, community attachment and participation. The third finding was about the influencing elements on the role of communal space renewal in community development. Residential environment, characteristics of the residents and community governance are key elements. When the residential environment is poor, such as in traditional housing estates and work-unit compounds, the communal space renewals were in great demands. But the communal space renewal indirectly led to the changing of social capital, sense of community, community attachment and participation. However, characteristics of the residents combined with community governance directly led to the changing social capital, sense of community, community attachment and community participation.

DISCUSSION

In Shanghai, there were different governance structure, residential environment, and features of the residents in different housing estate types. When discussing community governance in different housing estate types, there were different institutional arrangements, and different power relations between Residents' Committee, Property Management Company, and Homeowners' Associations. In terms of governance structure, the domination of the government and the role of Residents' Committee were gradually weaker from Traditional Housing to Work-Unit Compounds to Commodity Housing Estates, and the active of Homeowners' Association was gradually stronger from Traditional Housing to Work-Unit Compounds to Commodity Housing Estates. As for the location, most Traditional Housing was located in the core city center, which surrounded by Work-Unit Compounds, and Commodity Housing Estates were dispersed. This means that although Traditional Housing and Work-Unit Compounds were in poor physical environment, but with better public service and facilities accessibility. When discussing characteristics of the residents, the income in Traditional Housing and Work-Unit Compounds were small, but the education level in three types of housing estates was quite similar. Characteristics of the residents in different housing estate types were still different in both demographic information and socio-economic backgrounds. But it's taking risk to say the rich or the well-educated residents were enhancing elements in community development, but features of residents did influence the role of communal

space renewal performance in different situations. All these were explanation elements to understand the different performances of sense of community, community attachment, social capital and community participation in certain type of housing estate with and without communal space renewal and management.

CONCLUSIONS

Shanghai community development model is typical government dominated approach, in which the role of grassroots government, Street Office and Residents' Committee played important roles in all the three housing estate types. Under contemporary context, Shanghai was experiencing small-scale community renewal, especially, communal space renewal and management programs and projects. Various community organizations, residents and stakeholders were motivated in community development. This study was taken to explore the role of communal space renewal and management in Shanghai community development, by evaluating and explaining social capital, sense of community, community attachment and community participation, in particular. Communal space renewal and management could contribute to community development in different ways and in different housing estate type context. Exploring the role communal space renewal and management in community development Shanghai Model could have great significance for theoretical debates, community planning strategies and community development policy implications.

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REFERENCES

Bray D. (2006) Building 'community': new strategies of governance in urban China, *Economy and Society*, 35(4), 530-549

Craig G. (1998) Community in a global context, *Community Development Journal*, 33(1), 2-17

Dekker K. (2007) Social capital, neighborhood attachment, and participation in Distressed urban areas: a case study in the Hague and Utrecht, the Netherlands, Housing Studies, Vol. 22, No. 3, 355-379

Derleth J. & Koldyk D.R. (2004) The Shequ experiment: grassroots political reform in urban China, *Journal of Contemporary China*, Vol. 13, Issue 41, 747-777

Hays R.A. and Kogl A.M. (2007) Neighborhood attachment, social capital building, and political participation: a case study of low- and moderate-income residents of Waterloo, IOWA, Journal of Urban Affairs, Vol. 29, No.2, 181-205

Wu F. (2012) Neighborhood attachment, social participation and willingness to stay in China's low-income communities, Urban Affairs Review, 48(4), 547-570

Zhu Y., Breitung W. and Li S. (2012) The changing meaning of neighborhood attachment in Chinese commodity housing estates: evidence from Guangzhou, Urban Studies, 49(11), 2439-2457

RESEARCH ON THE GOVERNANCE MODALITY OF URBAN VILLAGE IN CHINA BASED ON INTEGRATION OF INCLUSIVENESS AND URBAN SERVICE BOUNDARY

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Abstract
Due to rapid urbanization, urban village has gradually become a populated area dominated by a large number of floating populations in China. Similar to the slums, the problems of urban village, such as poverty, housing, infrastructure and social governance, need to be solved urgently, which is always a serious issue in urban governance. Therefore, based on the past experience from the international slums governance and typical case of urban village in Hangzhou, this paper builds the framework for urban village governance modality, which integrates inclusiveness with USB as the guiding principle, and aims at people-oriented service using housing and infrastructure as specific means. This paper proposes that inclusive city should consider different needs of people inside and outside the urban village and incorporate urban village into USB. On the basis of distinguishing different functional positioning of urban villages, urban villages should adopt differentiated housing and infrastructure construction in order to meet the needs of different groups in order to form the differentiated and systematic governance modality.

Keywords: Inclusiveness, Urban Service Boundary, Urban Village, Governance Modality

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INTRODUCTION

City has always attached great importance to social justice, citizenship and social integration (Gary and Sophie, 2002). In the past 60 years, the global urbanization rate has increased by 21%, and above 50% of the world's population living in cities will reach 60% in 2030 (United Nations, 2015). However, as Aristotle said in Political Science "In fact, we cannot consider all the people who keep city running into citizenship", there are still a large number of vulnerable groups living in slums and urban villages in various countries, being in poverty for a long time. These vulnerable groups are excluded from the economic, social, political and cultural systems and are difficult to integrate into the cities (Cappo, 2003). The poverty issue in the slums and urban villages is undoubtedly a major threat and challenge to the stability and development of the human society. In 2015, The United Nations even listed "end poverty in all its forms everywhere" regarded as a social target as one of the 17 SDGs (Sustainability Development Goals). People's understanding of poverty goes through a deepening process from income poverty, capacity poverty to rights poverty (Cai, 2009). Amartya Sen (1982) thought that the poverty population lacked the ability and opportunity of creating income, while Muhammad Yunus (2009) thought that the source of poverty was the system that imprisoned people's free development. It can be said that the problem of poverty in slums and urban villages is caused by the lack of inclusive governance.

In order to solve this problem, the United Nations, the World Bank and the Asian Development Bank often refer to the concept of inclusiveness, such as Inclusive Social Development in 2004 (Asia Development Bank, 2005), Inclusive Growth in 2007 (Asia Development Bank, 2008), Inclusive Development Strategy in 2008 (Growth and Development Committee of World Bank, 2008), Social Inclusion in 2013 (World Bank, 2013), and "make cities inclusive, safe, resilient and sustainable"(United Nations, 2015). It is widely accepted by international organizations and academia that inclusiveness is equal treatment to different regions, ethnic groups and cultural differences. That means all citizens have the rights and methods to participate in social development and share the fruits of development fairly and reasonably (Qu, 2012). The core element of inclusiveness should be the comprehensive public service system and the full participation of individuals (Ge, 2014; Berkman, 2001). The slums and urban villages are the products of urban governance without inclusiveness. From the perspective of urban growth management, slums and urban villages are inside city, they are actually excluded by the USB. Through controlling urban infrastructure construction, the purpose of USB is to attract and constrain the urban growth within the boundary and avoid growing on the areas without infrastructure investment (Pendall et al., 2002). Since the economic costs of reconstruction and governance of slums and urban villages are too high, the government doesn't have incentives, which, in turn, results in the lack of inclusive governance in slums and urban villages.

In the early stage of slum governance, most countries actually excluded them from USB and refused to provide infrastructure and public services. Until the deterioration of slum affected urban growth and social stability, government began to regard the slum as an organic part of the city and incorporated it into the USB. Through providing slum with infrastructure and housing, the condition of slum is gradually improved.

Although in China the name, land property and architectural structure of urban village are different from slum's, both can be seen as common phenomenon essentially in the process of urbanization due to high-speed urban migration and unsafe land property rights (Li, 2004; Wallerstein, 2011). Rapid urbanization has contributed a large number of floating populations into Chinese cities, but meanwhile caused excessive land development and rising housing prices, which have seriously jeopardized the sustainable

development of the society (Wu et al., 2016). These problems resulted in massive migrants in urban village, but city has not incorporated it in the USB yet. Hence, urban villages in China have brought about various problems, such as population poverty, land utilization, landscape construction, planning and management, community culture and administrative system (Yan et al., 2004).

At present, urban village in China has become an inhabited area with a large number of floating populations. The problems of inefficient land use, confusing household registration and complex social governance will aggravate the poverty problem among villagers in urban villages, making it difficult for migrants to integrate into cities, and thus affect the sustainable growth of cities. The government should systematically bring urban migrants into the category of urban residents and allow them to enjoy various social security, and thus curb the resurgence of urban villages (Wu, 2011). Therefore, this paper integrates inclusiveness with USB as the guiding principle of urban village governance, taking the people-centered governance as objective, housing and infrastructure as the specific means, combining with the experience of the typical international slums management and the case of urban village in Hangzhou, China, to build the urban village governance modality framework, so as to propose governance modality suitable for urban village in China.

EXPERIENCE OF INTERNATIONAL SLUM GOVERNANCE

The governance of slum in western countries is mainly due to the reconstruction of old city. However, the governance of slum has brought a lot of negative impacts because of the lack of theoretical guidance in the early stage. Lewis Mumford (2010) once pointed out in History of Urban Development that urban renewal was only superficial work, while it was still actually an aimless centralized destruction. Through the constant exploration, western countries have achieved great results in the governance modality of international slums. Through reviewing the literature, this paper summarized three comprehensive governance modalities of focusing on housing, new-type community activities and local legalization, respectively represented by the United Kingdom, the United States and Brazil.

Governance Focusing on Housing

The slum governance in the United Kingdom mainly focused on housing, involving the housing itself and the housing security, the environment of residence and social governance.

In the late 19th and early 20th centuries, the United Kingdom recognized that the root cause of slums was the inadequate supply of workers' housing. The government started to implement government-led slum clearance and public rental housing construction (Xu, 2012). Until the 1980s, Britain terminated government-led housing construction. The 2008 Housing and Regeneration Act gave family community agencies power to implement slum renovation, encouraging residents to improve their housing conditions.

Slums of the United Kingdom were accepted gradually and incorporated into the USB. On the one hand, the government adopted a gradual renovation of slum to recycling use the original slum space through a series of means, such as reusing the historic buildings in traditional streets, converting the abandoned office buildings to apartment housing. On the other hand, it proposed the sustainable mixed residential model, which made full use of the abandoned land to build the mixed community, providing low-income people with a variety of housing options and avoiding space isolation of social classes and the emergence of slums. In terms of urban infrastructure, the people-centered approach considered sanitary conditions, water supply and drainage, transportation and

social isolation, such as 2004 Housing Act—Housing, Health, and Safety Rating System set the standards of housing damp heat and pollution prevention. At the same time, it took into account the psychological factors of residents, such as the Housing Law set various factors that affect people's psychological stability as the slum renovation standards.

New-Type Community Renewal

This modality is represented by the United States, and slum governance is the content of the Neighborhood Recovery Plan. In the early days of slum governance in the United States, the government's understanding and treatment mode of slums were also the exclusion, eviction and clearance. At the same time, the construction of low-rent housing could not keep up with the demolition progress. Only 36% of the cleared land was still used for housing construction, which was basically designed for the upper class and not the low-cost public house stipulated in the bill (Schussheim, 1970). Most slum dwellers could only move into other densely inhabited area (Hill, 1966), leading to the annihilation of existing social networks and inducing the renascence of slums elsewhere.

Based on practical lessons, the United States launched the Neighborhood Recovery Plan. The slum governance was no longer seen as an isolation problem but was incorporated into the recovery plan of the central urban areas, as well as established a systematic policy centered on economic measures in turn. policy. The goal of the CDBG (Community Development Block Grant) was to improve slums, maintain historical buildings and improve community facilities. It attracted property developers through preferential policies and took them as the mainstay to promote the construction of low-rent public housing and improvement of public facilities. The public project work and employment tax credit created 60,000 job opportunities for the slum dwellers. At the same time, the CDBG maintained historic buildings and preserved the historical and cultural traditions of slums (Wu et al., 2008).

The Legalization of Occupied Land

In the early days of slum governance in Brazil, the government adopted a set of measures to curb the growth of slums, such as prohibiting the occupation of shared or private land, placed the slums completely outside urban planning. However, it was difficult to prevent the poor from flooding into the cities and the government cannot stop the behavior of encroaching land.

Brazil gradually explored the governance modality that focused on the legalization of occupied land. Brazil government gave a policy of land legalization to some regions with relatively mature conditions. Government recognized the land ownership of the landowners and gave the long-term living confidence for slum dwellers. On this basis, Brazil continued to increase investment in slum infrastructure, such as the Urban Renewal Plan for Slum Dwellers implemented by the Government of Sao Paulo from 1989 to 1992. According to incomplete statistics, from 1991 to 2000, the sewage treatment level in Sao Paulo's slums increased from 4.0% to 95.3%, and the garbage recovery rate also increased from 73.8% to 98.9%. At the same time, Brazil incorporated the slums into the urban development system and increased the urban social integration of slum dwellers. The typical representative is the Slum Community Plan implemented in Rio de Janeiro in 1995, which integrated slums into urban development planning, and focused on the development of slum health and education.

Comparison

Reviewing the experience of slum governance in the United States (Table 1), the United Kingdom and Brazil, the common characteristics can be summarized: They all excluded slums initially and carried out single-material clearance. They realized the significance of inclusiveness gradually and incorporated slums into USB, regarding people-oriented as the objective of governance. Besides, they adopted the measures combined with society, economic and culture based on housing and public infrastructure to encourage slum dwellers to accommodate into cities. This indicates that, in terms of governance concepts, three models all treat slums with inclusiveness, and provide infrastructure and public services for slums under USB guidance, starting from the objective of people-oriented to overcome the problems of slums. The difference is the specific implementation measures. The UK promoted the construction and improvement of infrastructure, the slum space regeneration and cultural renaissance by using the diversified housing model and the single law, which payed more attention to the human scale; in another hand, the United States adopted the funds of the Neighborhood Recovery Plan and marketization measures to advocate the construction of low-rent housing and infrastructure, protecting historic buildings and cultural traditions; Brazil recognized the private ownership of slum lands through local legalization and integrated slums into the urban development system, continuously investing in improving slum dwelling conditions and paying attention to further education and health of slum dwellers.

Table 1 Comparison of international slum governance

	Governance Concept	Implementation measures
United Kingdom	Inclusiveness Pay attention to the needs of slum dwellers Bring slum into USB People-oriented governance objective Focus on housing and infrastructure	Sustainable mixed residential model A large number of housing related laws Infrastructure improvement and historic building protection through housing improvement
United States		Use CDBG (Community Development Block Grant) to improve slums, maintain historical buildings and improve community facilities Construction of low-rent public housing and public facilities led by developers
Brazil		Legalization of occupied land Government-led infrastructure construction Integrate slums into urban development systems

The formation and status quo of China's urban villages are very similar with that of slums. The international experience has a reference value for the governance of urban villages in China. However, at present, the governance of urban villages in China is in the mid-term stage of the aforementioned countries, which is government-led and demolition-based. Although the government has specific measures for housing protection, it neglects the housing, infrastructure and cultural integration needed by the migrant population in the urban villages.

CASE STUDY

Combined with the international experience of the slums governance and the governance status of China’s urban villages, this paper built a governance modality framework of China's urban villages (Figure 1). This framework integrates inclusiveness with USB as

the guiding principle of urban village governance, taking the people-centered as objective, housing and infrastructure as the specific means.

Figure 1 Urban villages governance framework

This paper selects Sandun Town in Hangzhou as the study area for case study(Figure 1). Sandun Town is located in Hangzhou's urbanization rapid development zone, covering the main types and stages of the urban villages in the time and space latitude. It is helpful to formulate a suitable governance model through the case studies of different types of urban villages. On this basis, this paper selects Sanba community, Miaoqianjie community, Jihong community of Shuangdun Town as the research objects. Among them, Sanba community is located within city and basically in USB and has become part of the city. Miaoqianjie community is located within the city but not entirely within the USB, which is a real urban village. Jihong community is located on the edge of the city and far away from USB and is in the embryonic state of the urban village.

Figure 2 Location of urban villages in the case study

Sanba Community

Sanba community is located in the southeast of Sandun town. Since it faces Zhejiang University in the west and close to the subway station and commercial complex in the east. The surrounding housing and infrastructures are well-developed. Sanba community is almost in sync with the urbanization process during the process of urban village reconstruction. Sanba community has been located within the USB basically and become an integral part of Hangzhou (Figure 3).

Figure 3 Remote sensing image and modern community of Sanba community

In terms of housing, Sanba community has already carried out demolition and resettlement of the original residents. It built community residential settlements in the style of a modern urban community and built several high-density residential buildings on the original site. In terms of urban infrastructure, Sanba community is close to subway station, and has 37, 97, 132, 143, 211, 303/K303, K349 and other city buses. There are Wuzhou International Plaza, Hangzhou Impression City Shopping Center, Hangzhou Chengxi Yintai in the modern city comprehensive shopping mall. The school includes a complete set of teaching facilities from kindergarten to university.

Regardless of housing or urban infrastructure, Sanba community is very complete in these, which can absorb a number of people with the magnitude increase. However, with the completion of the infrastructure and public services surrounding the Sanba community, the prices of housing and rents are also growing rapidly. The middle- income and high-income floating population gather here. The lack of government support for the low-income migrants makes it difficult to stay here, and thus they transfer to other urban villages, which not only promotes the deterioration of other urban villages, but also leads to the renascence of urban villages elsewhere.

Miaoqianjie Community

Miaoqianjie community is located in the core area of Sandun Town, which used to be the administrative center. There are 3051 natives with a total population of 7400. The scale is five to ten times that of other urban villages in Sandun Town. There are tens of thousands of migrants living here. Due to the high cost of demolition and relocation, the Miaoqianjie community has not yet been fully covered by the USB. In terms of housing,

road traffic, water and electricity supply, property and hygiene, public security and fire protection, it has a gap with modern cities (Figure 4).

Figure 4 Remote sensing image and miscellaneous district of Miaoqianjie Community

In terms of housing, Miaoqianjie community is near to the west area of Hangzhou, and there is a business district. The favorable location and relatively low rental prices have attracted a large number of migrants. The income from rental housing has stimulated the natives to build various illegal buildings, with the prominent feature of dirty, messy, poor, and dense. In terms of infrastructure, due to the rental phenomenon and the increase in the number of residents, the infrastructure in Miaoqianjie community has been overloaded, while the population density does not reach the level of population absorption in modern cities.

Miaoqianjie community is a typical urban village, which belongs to the city in terms of geographical space but is excluded from USB in the aspect of urban infrastructure and public services. Although its original infrastructure has attracted a large number of low-income migrants, which satisfies the needs of residents for work and life to a certain extent, will only increase the deterioration degree and difficulty of governance on urban village. Miaoqianjie community has a certain infrastructure, close to the city commercial complex, Zhejiang University, with great economic potential and a certain history and cultural traditions. Therefore, Miaoqianjie community should not be dismantled and rebuilt, and it is more appropriate to carry out small-scale and incremental transformation through USB guidance. At the same time, due to the fact that the number of migrants is far more than that of natives, government should provide affordable housing and rental housing for the low-income migrants except high-density housing. In addition, the Miaoqianjie community has a certain historical tradition, which should be paid attention to for protection, encouraging people to integrate into the city.

Jihong Community

Jihong community belongs to the outlying area of Sandun Town, with an area of 2.75km2 and 2758 natives. Due to its vast area, about 50% of the land in the Jihong community are farmland. Regardless of housing or surrounding infrastructure and public services, Jihong community is still in the urbanization stage and has not yet been included by USB. It is not a strictly urban village (Figure 5).

Figure 5 Remote sensing image and demolition area of Jihong Community

As Jihong community has not yet been included by USB, compared with the real urban village, the number of migrants is relatively small and the supporting infrastructure such as transportation, shopping, and entertainment are relatively lacking. Although the rental price of the Jihong community is very low, the income from the low rent is not enough to offset the negative inconvenience caused by transportation inconvenience. If the governance cannot be followed in a timely manner, it will soon evolve into a real urban village. If referring to the governance method of Sanba community, the low-income groups will be excluded. Therefore, on the one hand, when the cost of demolition is not high, the problem of demolition and resettlement of natives should be resolved quickly, promoting the transformation of natives into urban residents. On the other hand, in view of the future flows from other cities and other urban villages in Hangzhou, it should lay out in advance and actively implement the strategy of building rental housing for collectively-operated construction land.

Comparison

Through the case analysis, we can find that the coverage of USB is realized in time in Sanba community. The natives have been compensated and resettled, and the demand of medium/high income groups for high-density housing and improved infrastructure conditions has been met. However, the low-come floating population gradually spread to other urban villages because the government ignored the needs of the floating population for low-rent housing and public rental housing, and the high-quality infrastructure of the Sanba community pushed up the house price and rent.

The Miaoqianjie community is the completely formed urban village. The high cost of demolition makes it excluded from the USB. It is difficult to solve the problem through demolition. At the same time, the Miaoqianjie community has absorbed thousands of external populations, and it has historical and cultural traditions. So it is very difficult to take into consideration all kinds of people inside and outside the urban village. Therefore, different types of housing, infrastructure and protection of historical and cultural traditions should be considerd through USB.

Jihong community is still in the embryonic form of urban village, but it is now in the stage of rapid urban development. However, it’s governance modality cannot copy that of Sanba community. Considering that Jihong community is located at the edge of the city and the infrastructure condition is weak, the needs of employees in low-end industry and low-income groups should be mainly considered. The government should provide

low-rent housing and public rental housing with basic public services in order to absorb migrants from other urban villages and other cities.

RESEARCH DISCOVERY

Through the case analysis, it can be found that there is a universal law on the idea of the governance of urban villages: The governance should focus on the natives and floating population inside and outside the urban village and enhance the city's integration degree of people through housing, infrastructure and protection of historical and cultural traditions. But different types of urban villages vary in housing, population size, and demolition costs. Therefore, different governance modalities suited to urban village are inevitable. Based on the case analysis, the paper improves the frame (Figure 6).

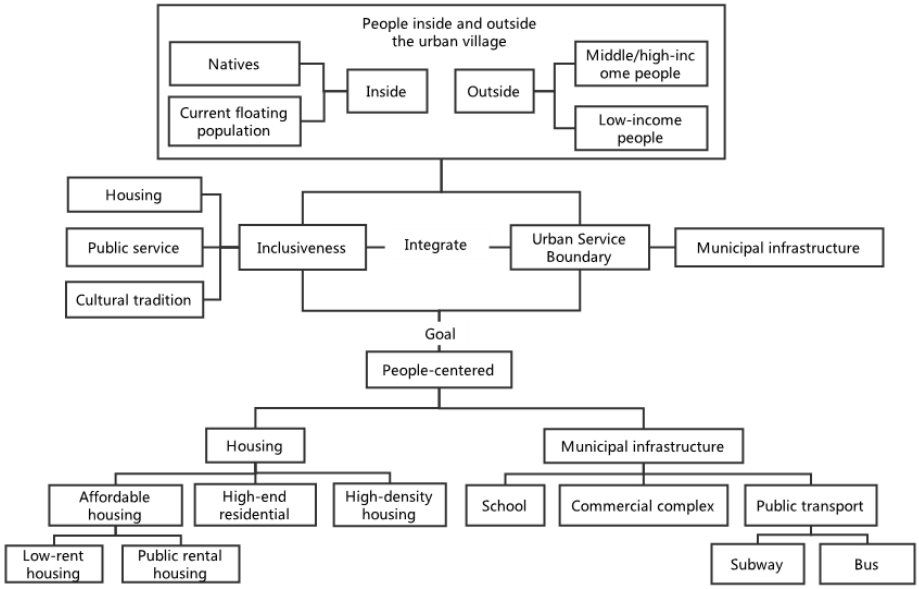

Figure 6 Urban villages governance framework

Inclusiveness

The government should consider the actual needs of different groups inside and outside the urban village. The most important issue is the integration of floating population into the city. The inner population of urban village can be divided into natives and current floating population, and the people outside the urban village can be divided into middle/high-income people and low-income people. Natives need compensation and resettlement, and floating population needs low-rent housing on-site or off-site because they cannot cannot obtain resettlement housing caused by household registration. Middle/high-income earners need high-end residential and high-density housing with high-quality infrastructure and public services, while low-income people need low-rent housing, public rental housing with basic infrastructure. In addition, the inheritance and protection of the historical tradition is an important cultural factor to integrate the residents into the city.

USB

The government should adopt the USB to incorporate the urban village into the USB. On the basis of distinguishing the functional orientation of urban villages, the government should meet the needs of different groups of people with differentiated housing and infrastructure layout guided by USB, in order to form a hierarchical and systematic

governance modality of urban village. It is very important that USB should focused on low-income groups. On the one hand, it can avoid the emergence of the situation that Sanba community ignored the external low-income groups in the future urban villages, such as Jihong community. On the other hand, it can alleviate the housing and infrastructure pressures of the real urban village, such as Miaoqianjie community, and increase the urban integration degree of low-income groups.

People-centered governance

Different urban villages need differentiated implementation of housing and infrastructure aiming at people-centered governance. For urban village which is adjacent to schools, commercial complexes and subway, such as Sanba community, the needs of middle/high-income groups should be mainly considered. They need high-end residence and high-density housing with high-quality infrastructures because of huge economic potential in this type of urban village. For urban villages with a large floating population and basic infrastructure conditions, such as Miaoqianjie community, the needs of migrants should be mainly considered. They need high-density housing and public rental residence, with self-contained infrastructures. For urban village which is still in the embryonic form, such as Jihong community, the needs of employees in low-end industry and low-income groups should be mainly considered. They need low-rent housing and public rental housing with basic public services and it is important to improve the public transport system and develop public rental housing by using collective construction land.

CONCLUSIONS

At present, urban development in China have gradually transformed from rapid urbanization stage to high-quality urbanization stage. High-quality development requires the integration of different groups to provide impetus for the urban growth together. Meanwhile, China's population will reach its peak in 2030. Urban development needs to intensify the inflow of people and absorb a large number of laborers in the urban village. At the same time, the problem of poverty in urban villages is related to urban equity and social stability, and the systematic and differentiated governance on urban villages will affect not only the sustainable development of the city, but will also the inclusive growth of China in the future. Different urban villages contain different features of population, housing, infrastructure, thus there should be different governance modalities according to local conditions. Under the governance of urban villages. the city should be inclusive of urban villages and pay attention to the specific needs of people. In addition, city needs to integrate the urban villages into the USB and distinguish the functional area where different villages locate. Moreover, it should guide housing and infrastructure construction through the USB guidance and meet the needs of different groups of people with differentiated housing and infrastructure. Finally, it can form the differentiated and systematic governance modality.

REFERENCES

Amartya, S. (1982). *Poverty and famines*. Oxford University Press.

Aristoteles. (1965). *Politics*. Commercial Press

Asia Development Bank. (2005). ADB Annual Report 2004 https://www.adb.org/documents/series/adb-annual-report-2005.

Asia Development Bank. (2008), ADB Annual Report 2007 https://www.adb.org/documents/series/adb-annual-report-2008.

Berkman, L.F. (2001). Social integration, social networks, and health. *Social Science & Medicine*, 51(6), 14327-14332.

Cappo, D. (2003). Social inclusion, participation and empowerment. Acoss Info Papers.
Cai, R.X. (2009). The Concept of Inclusive Growth and Its Policy Implications. *Economist*, 1, 102-104.
Du, Y. (2008). Basic Practices in Brazil's Slum Governance. *Journal of Latin American Studies*, 1, 59-62.
Gary, B. and Sophie, W. (2002) *A Companion to the City*. Blackwell Publishers.
Ge D.S. (2014). Inclusive Social Development: from Concept to Policy. *Journal of Social Development*, 3, 212-228.
Growth and Development Committee of World Bank. (2008). *Commission on Growth and Development.* Beijing, China Finance Press.
Hill, H. (1966). Demographic Change and Racial Ghettos: The Crisis of American Cities, *Journal of Urban Law*,1966, 44, 258.
Li, J. F. (2004). *The Reconstruction of the Village in City*. Beijing, Science Press.
Li, R.Z. and Li Z.S. (2006). The Analysis and Enlightenment of the Urbanization Pattern of Brazil. *Urban Problems*, 4, 93-98.
Muhammad, Y., Jonathan, R. & Lu, X.Y. (2009). Micro finance, Social Enterprises and Anti-poverty in the Era of Crisis. *Economic Science*, 3, 5-14.
Mumford, L. (2010). *The City in History: Its Origins, Its Transformations, and Its Prospects*. Harcourt, Brace & World.
Pendall R., Mrtin, J. & Fulton, W. (2002). *Holding the Line: Urban Containment in the United States*. The Brookings Institution Center on Urban and Metropolitan Policy.
Qu, J. D. (2012). The Concept and Assessment of Social Development. *Annual Report on Social Development in China.* Beijing, China Social Sciences Press.
Rodrigues, R.I. & Kanto, S. (2007). Slums upgrading in brazil during the 1990s: an evaluation using census data. Paper Presented at the World Bank Fourth Urban Research Symposium, Washington DC.
Schussheim, M. (1970). Housing in perspective. *The Public Interest*, 19, 18-30.
United Nations (2006). *The Slum Challenges: Global Human Settlements Report 2003*.Beijing, China Architecture & Building Press
United Nations (2015). World Urbanization Prospects: the 2009 Revision. http://www.ctc-health.org.cn/file/2011061610.pd.
United Nations (2015). *Transforming our World: The 2030 Agenda for Sustainable Development. New York*, United Nations Press.
Wallerstein, I. (2011). *The Modern World-System III:The Second Era of Great Expansion of the Capitalist World-Economy, 1730s–1840s*. California, University of California Press.
World Bank. (2013). Inclusion Matters: The Foundation of Shared Prosperity, Washington, DC: World Bank.
Wu, Y. Z., Luo, J.J., Zhang, X.L., & Skitmore, M. (2016). Urban growth dilemmas and solutions in china: looking forward to 2030. *Habitat International*, 56, 42-51.
Wu Y. Z. (2011). *Study on the Temporal and Spatial Evolution of Urban Housing Price*. Beijing, Science Press.
Wu X., and Wu M.W. (2008). Reconstruction of Slums in Rapid Urbanization of USA. *City Planning Review*, 2, 78-83.
Xu Z.Q. (2012). An Analysis of London Slums and Labour Housing Construction from 1840 to 1914. *Collected Papers of History Studies*, 1, 121-128.
Yan X.P., Wei L.H., & Zhou R.B. (2004). Research on the Coordination Between Urban and Rural Area in the Rapid urbanization With the Redevelopment of Guangzhou Village-Amid-the-Ctiy Asa Case. *City Planning Review*, 28(3): 30-38.

IAD-BASED AFFORDABLE HOUSING POLICY UNDER THE NEW-TYPE URBANIZATION IN CHINA

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Abstract
As the rapid urbanization and the deepening of housing system reform in China, the housing problems of increasing floating population in urban area come into hot spots. The core content of *The National New-type Urbanization Planning (2014-2020)* is to encourage eligible workers who were engaged in agricultural to gradually become urban dwells. Housing affordability is the key to achieving the New-type Urbanization. This paper starts with a review of the changes in affordable housing policies in China. And then an analysis model of the affordable housing policy based on the IAD framework is introduced, to bring forward the guidance and rules of affordable housing policy. Moreover, the implementation effects of the policy rules have been elaborated, taking Hangzhou as a case. Finally, this paper provides several constructive guidance and rules in affordable housing policies aimed to enlarge its scope of coverage, in order to greatly enhance the housing affordability in China.

Keywords: Affordable Housing; IAD Framework; New-type Urbanization.

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INTRODUCTION

As deepening of China's reform and opening-up policy and the accelerating process of industrialization, China's urbanization has experienced a high-speed developing process. Data from The National New Urbanization Planning (2014-2020) shows that by 2013, the urban resident population increased from 170 million to 730 million, and the urbanization rate increased from 17.9% to 53.7%, with an average annual increase of 1.02%. The National New Urbanization Report 2016 shows that China's urbanization rate reached 57.35% in 2016 which indicated it is of great significance to implement New-type Urbanization in the country. Moreover, The United Nations (2012) predicted that China's urbanization rate will reach 69% in 2030.

Urbanization has absorbed a large number of rural migrant labor. Thus prominent contradictions and problems which should be attached great attention to arises. A large number of agricultural population is difficult to integrate into the urban society and the process of citizenization is lagging behind. Housing is a necessity for human survival. How to satisfy the housing demand of the middle and low income residents is a major issue related to the national economy and the people's livelihood. Building a housing security system suitable for China's social and economic development is one of the most urgent problems to solve. The nineteen Party Congress report reiterates that "housing is for living in, not for speculation", and focuses on the establishment of better housing system for everyone. Except the need of low-income urban residents, a large number of new urbanization population also long for the implement of government's new affordable housing policy, which is the key to the quality of New-Type Urbanization.

At present, migrant workers make the majority of China's industrial workers. Affected by the household registration system between urban and rural areas, they are unable to enjoy basic public services as urban residents in education, employment, health care, pension and affordable housing. The current housing security system mostly focus on the housing problems of urban residents while ignoring the floating population. As the improvement of the level of urbanization, a large number of urban migrant workers and all kinds of professional talents have been continuously poured into the city. Most of them can not afford commercial housing, which means the government should provide a large number of affordable housing such as public rental housing, low-rent housing and other housing forms to meet the needs of different levels of housing demand, and establish a more extensive and reliable housing security system.

China's current affordable housing policy system consists of economically affordable housing, low rent housing, public rental housing and various shantytowns for the social "sandwich class". At the same time, some scholars are exploring the model of the property-right-shared housing. The policy model includes two main directions: the brick subsidy and the currency subsidy. The former is that the government reduces the land-transferring fees paid by constructors. Then they sell or rent the affordable housing at a lower price compared to the commercial housing. While the latter is currency subsidies from government for the applicants realize purchase or rent housing in the real estate market, such as housing vouchers.

In recent years, the rapid development of affordable housing construction (quantity, investment and scale) has effectively improved the housing conditions of the poor people, played a positive role in promoting consumption and expanding investment, and promoted social harmony and stability. But we should also see that faced the target of renewal of urban shanty towns and villages where about 100 million people living, the task is still arduous. There are still many difficulties and problems in renewal techniques, finance and the basic infrastructure.

The construction of China's affordable housing is mainly invested by public finance. But this does not mean the absence of social funds. The price of commercial housing has been rising rapidly, far beyond the level of residents' income growth. Meanwhile, the rigid demand of residents for housing has also been at a high level, resulting in the rapid rise of the demand for affordable housing construction. The local government in China mainly depends on the "land finance". On this basis, through reasonable policy making, the access of social and private capital in the housing construction is an inevitable trend. Since 2012, the Ministry of housing construction has encouraged private capital to enter the housing construction, and many cities became pilots. It is proved an effective measure to relieve the pressure of local governments. Hopefully, it will be an inevitable trend in the large-scale construction stage of affordable housing in the future.

When facing the inadequate supply of land, funds shortage and other difficulties, reasonable policy guidance and rules is the key to the great implementation of housing policy and to promote the quality of New-Type Urbanization. This paper introduces an analysis and development framework of affordable housing policy to clarify the influence of internal and external variables and explore the rules of the implementation of the policy.

BUILDING IAD FRAMEWORK ON AFFORDABLE HOUSING POICY ANALYSIS

The Institutional Analysis and Development framework (IAD framework for short) is proposed by Eleanor Ostrom (2010). So far, the framework has been widely used to solve various social problems, including social ecological system in the allocation of public resources, public finance research, knowledge sharing at the age of digital information, partnership between enterprise and the organization. The framework mainly consists of four parts: context, action arena, patterns of interaction and outcomes(Fig.1).

Based on the IAD framework, the author introduces an analytical framework for the affordable housing policy(Fig.2). It shows the supply of affordable housing is how influenced by the institution (rules), biophysical conditions and community foundation (Endogenous variable) which also influence the structure of action arena (a kind of social space where the interaction between stakeholders happen), as well as the resulting outcomes. Moreover, the relationship between the rules that affect situation and the resulting outcomes generated by participants is also important. Exogenous variables of affordable housing policy conclude regional development and facilities, urban characteristics, institutional policies and other variables. The endogenous variable is the internal factor that affects the supply of urban affordable housing, and the exogenous variable is external driving force. The interaction coupling between the two has a decisive impact on the policy effectiveness of affordable housing.

Figure 2 shows how rules affect variables in action situation in the policy change of affordable housing. This paper aims to study the guidance and rules of affordable housing policy under the New-Type Urbanization.

The affordable housing policy is usually formulated by the government, and the government often encourages the developers and other non-governmental organizations to work together to ensure the supply of affordable housing. They are all the stakeholders including policy direct beneficiary. Based on this IAD framework, the action arena can be as large as the whole country, or can be a city. The government makes decisions in this particular environment. Action situations refer to that the government can provide new affordable housing on the supply side, and increase the supply of affordable housing through other ways, or provide reasonable affordable housing subsidies to the public. Developers participate in the construction of affordable housing through preferential

conditions such as tax deductions from the government or the lessen of land-transferring fees. At the same time, people officially apply for affordable housing according to their own financial conditions.

The independent variables that affect the affordable housing policy include: (1) Biophysical conditions;(2) Community attributes; (3) Institutional arrangements/ Rules-in-use.

(1) Biophysical conditions: The local government has formed a monopoly on the first level of land market in the present urban land supply system in China. They are trying to meet the market demand for the supply of land along with their own income maximization. Just like a relatively independent economic entity, in the process of land expropriation, some local governments will use their administrative powers to ensure that they become the biggest beneficiaries. With the drive of interests, affordable housing land is basically not guaranteed. And how to increase the land supply of affordable housing is an important challenge to implement affordable housing policy from the supply side. Government, enterprises and affordable housing buyers should share the cost together, and low-income groups purchase or rent affordable housing at prices below normal commercial housing market.

(2) Community attributes: The main financial sources of local government are tax and land-transferring fees. The government needs to consider the financial support of the new housing and its facilities. After 2006, China abolished the agricultural tax system. In the past, farmers needed to pay taxes on agriculture and special agricultural products. The government can no longer solve the problem of affordable housing through this funds. However, the tax burden of land use and land tenure is too low in China, as well as the pressure of the land holders. So it is difficult to form an economic constraint mechanism and incentive mechanism. With the rise of the urban land price, the real estate developers can gain the profit of land increment only by hoarding land, and promote the frequent occurrence of idle phenomenon after obtain the urban land. The current land tax system in China is generally only for the land involved in production and operation activities. Many administrative units and individuals are excluded from the taxation. At the same time, under the pressure of regional competition, many local governments must also take the initiative to reduce taxes, provide incentives for developers, which also led to narrowing the local government tax revenue, finally relying on the “land finance”. Moreover, the level of economic development of cities is different. Thus the implementation level and stage of affordable housing policy are also different. Based on local conditions, the stage of urban development pace should match the stage of affordable housing policy.

(3) Institutional arrangements/Rules: Seven types of rules could affect the action situation are:(1) Boundary rules that specify how actors are to be chosen to enter or leave a situation;(2) Position rules that specify a set of positions and how many actors hold each one;(3)Information rules that specify channels of communication among actors and what information must, may, or must not be shared; (4)Authority rules that specify which actions are assigned to a position at a node;(5) Aggregation rules (such as majority or unanimity rules) that specify how the decisions of actors at a node are to be mapped to intermediate or final outcomes;(6)Scope rules that specify the outcomes that could be affected;(7) Payoff rules that specify how benefits and costs are to be distributed to actors in positions. Each rule is associated with multiple variables, and the changes in the rules affect one or more variables.

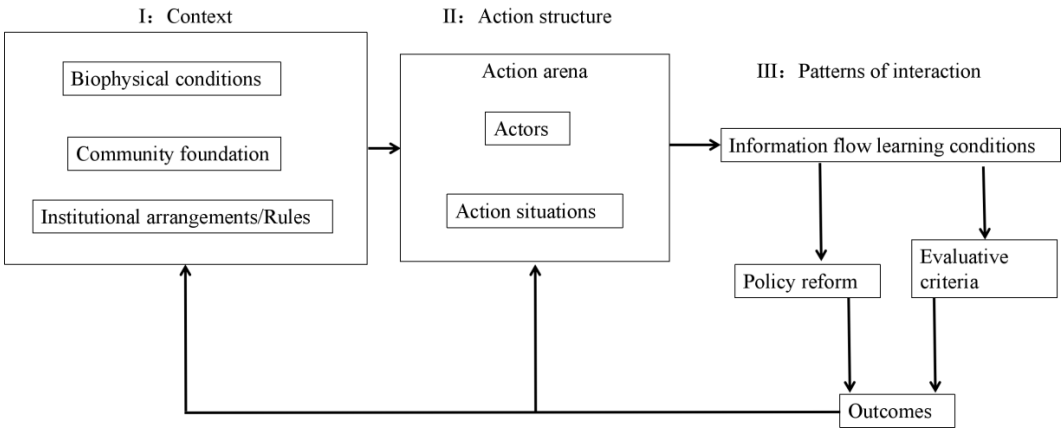

Figure 1 IAD framework

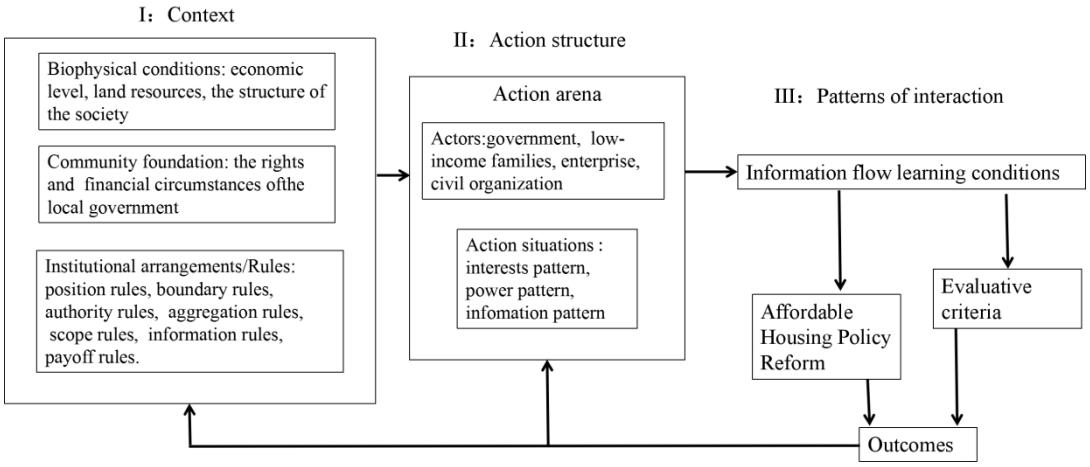

Figure 2 IAD framework on Affordable Housing

THE RULES OF AFFORDABLE HOUSING POLICY BASED ON NEW-TYPE URBANIZATION: A CASE OF HANGZHOU

On the basis of a large number of case studies, Ostrom concluded that reasonable rules and institutional arrangements will make public resources governance more efficient. Hangzhou will be taken as a case in to analyze the implementation of the current affordable housing policy and the direction of improvement in this paper.

The goal of government during the “Thirteenth Five-Year Plan” period in Hangzhou is to deepen the reform of the housing system and to meet the housing supply of the new citizens, and to establish a housing system for both purchase and rent. At present, Hangzhou has basically formed a multi-level urban housing security system based on economically affordable housing, low-rent housing, public rental housing, and resettlement housing for shanty towns.

Boundary rules

Clear boundaries include the boundaries of resources and the boundaries of resource users (have the power of the allocation of resources, such as government, developers, etc., and the coverage of the population that accept the allocation of affordable housing.)

(1) Land resources insurance still needs to be strengthened. According to the Twelve Five-year Plan of Hangzhou Affordable Housing and Real Estate Development Report, in the “Eleventh Five-Year Plan” period, the government has established five mechanisms: affordable housing for low-income families, economic income joint

investigation, daily services, strict after-sale management and impartial supervision. In 2006-2009, new affordable housing construction area in the main city of Hangzhou has reached 416.4 million square meters, nearly 40,000 difficult families have solved the housing problem. After years of continuous land development, the land area for construction is becoming smaller. The follow-up land supply will mainly rely on the potential land stock. Taking the main urban zone of Hangzhou as an example, Figure 3 shows that since 2009 and during the Twelve Five-Year Plan, the land supply area showed a declining trend.

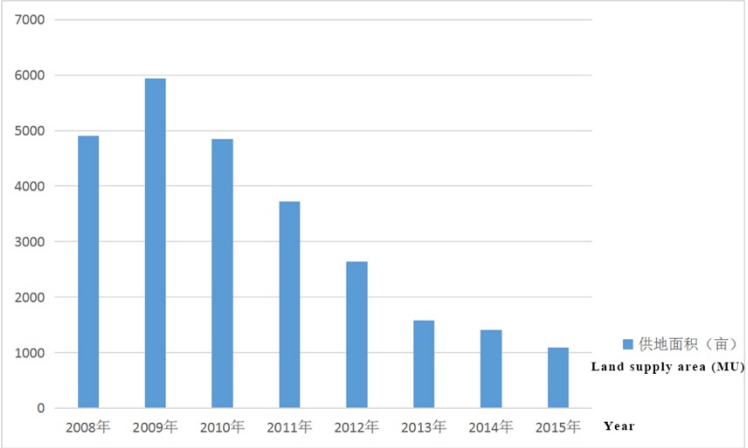

Figure 3 The supply of land area for affordable housing in main urban zone of Hangzhou (2008-2015). Resource from: Government official website of Hangzhou

(2) As the deepening of New-Type Urbanization, public rental housing gradually replaced the economically affordable housing and became the main part of affordable housing system. As well as the local household registration with low income, new college graduates who are newly employed and migrant workers in stable working conditions also have the right to apply for public rental housing. Because of the low income and high cost of rent, graduated college students and migrant workers usually choose to rent or live in urban village. However, with the large-scale resettlements of people in urban villages and the rapid rise of rents recent years, their housing problem have been exacerbated. It is urgent for the government to strengthen the basic housing guarantee for these groups, which is also an important responsibility to improve the basic public service nearby. By the end of September 2015, the coverage rate has reached 29% of the urban population. Among them, low-rent housing has covered 11921 households, achieving the minimum standard 2.5 times less than the income of low-income families that “should be guaranteed”; economically affordable housing has benefited 83912 households; public rental housing covered 22,720 households.

(3) It is necessary to establish strict access and exit mechanism of affordable housing is. The effective exit of affordable housing always has been a huge problem. If the family can not exit in time because of the change of their own conditions, the fairness and efficiency of the allocation of housing resources will be affected. The lease period of the public rental housing in Hangzhou is 3 years. After the period, if the lessee still matches the condition, he can apply for renew the lease. Except for the low-income urban families, the lease period shall not exceed two lease terms. During the three months prior to the expiration of the lease, if the lessee needs to continue the lease, the application shall be submitted by the employing unit to the leased management agency for renewal. After the investigation, the lessee may renew the lease contract. If they no longer match the

condition, the rent management agencies can withdraw the affordable house. As for the low-rent housing, people also should have the qualifications.

Position rules

During the affordable housing policy-making process, government at all levels play a vital role. The power of other stakeholders such as the developers and housing security groups is relatively weak. At present, the methods for newly-built affordable housing can be divided into three types: 1) Mainly the construction of economically affordable housing, and the government organizes and supervises the construction of affordable housing built by enterprises, and enterprises are responsible for the quality. 2) The Housing Development Center established by the government is responsible for the development and construction of affordable housing. At present, the National Low-rent Housing Development Center, as the government's legal franchise development agency, is responsible for implementing the government's low-rent housing development plan. 3) Financing and cooperation building. Centre and local government, and enterprise organizations will be mobilized and ensure the polarities of all parties, reflecting the mode of housing construction that all parties reasonably share. The funds for the cooperative construction of housing are mainly based on individual fund-raising, and all parties conduct comprehensive supervision on the construction of affordable housing.

In 2014, all levels of finance in Hangzhou from the higher levels of financial subsidy income, land financial income, housing accumulation fund value-added income, rental income and other means raised special funds of 4,550 million Yuan and other social funds of 1,060 million Yuan. All kinds of social financing have established a good platform for the housing construction for low-income families, and have played a positive role in improving their livelihood. As for the operation of the organization, the government has established all levels of social affordable housing construction and management office and urban construction management department, which are responsible for the overall coordination of affordable housing. The relevant departments should closely cooperate to ensure the progress of construction. In the affordable housing management, the responsibilities of various departments should be clear and try to realize the implementation of dynamic management of information resources.

Information rules

The Hangzhou Construction Commission opened a website for information on the construction of affordable housing in Hangzhou. Every month, the government will issue a briefing on the reconstruction of shanty towns and the construction of affordable housing projects. For the main part of the construction of affordable housing, intensive conservation should be adopted as the principle, and supervision and management should be strengthened. Developers should be required to implement the construction according to the planning standards and eliminate the waste of land resources. At the same time, the establishment of a developer's reputation file will incorporate user satisfaction into the developer's comprehensive evaluation system. In addition, compared with the surrounding ordinary commercial housing, reasonable planning space applications are made to promote the orderly development of the real estate market. On the public website of the Hangzhou Housing Security and Real Estate Bureau, there is an archive of creditworthiness for development companies that can receive public supervision and complaints.

Authority rules

Recent years, the construction of affordable housing projects in Hangzhou is more diversified. The agent construction, BT mode and other new construction mode showed up and achieved good results. For example, Hangzhou Hangyang block demolition resettlement housing project by the implementation of Greentown Real Estate Company, made full use of the project regular meeting system, residential supervision platform. It paid attention to the communication with the participating people, strengthened the quality and safety progress supervision. With the internal control construction, the project is promoting in a solid and orderly way.

At the end of December 2016, Hangzhou has been ahead of schedule and over the completion of the shantytowns and affordable housing construction tasks — started building 70,074 units and completed the 100% of annual target; achieve completion of 58,664 units,125% of the completion of the annual completion of the objectives and tasks. Promoting the shantytowns, villages in the city has gradually become a main supplement of affordable housing. For the urban renewal and reconstruction of old urban areas and urban villages, these low-income groups are helped to improve the living conditions in situ, and new development activities are encouraged to achieve moderate mixed living of different classes. This will promote the integration of various groups in society and facilitate social harmony.

Since the late 90s of last century, Hangzhou has begun to carry out affordable housing construction. After nearly two decades of development, the status of economically affordable housing is also gradually changing, from the beginning of the low-profit commercial housing into the main part of affordable housing, and now to the gradual weakening status. According to the Hangzhou affordable housing projects, the data shows that in recent years affordable housing starts showed an overall downward trend. (Shown as Fig.5)

Figure 5 The planning of affordable housing construction in Hangzhou

Year	Economically affordable housing	Public rental housing
2013	7574 units（534400m^2）	7690 units（420000m^2）
2014	4599 units（341800m^2）	5285 units（364500m^2）
2015	2760 units	1531 units

This also reflects that based the increasingly tight supply of land in Hangzhou, urban housing security system is gradually realizing the shift from increasing expansion to excavating inventory. It is worth noting that the Hangzhou Housing Security Department began to “suspend applications for affordable housing, suspend new sites for building affordable housing, public rental housing,” and “implement the monetary subsidy system for public rental housing at the municipal level”.

Aggregation rules

Hangzhou adheres to the development concept of “marketization” and “monetization”, pays attention to the basic role of market allocation of resources, implements housing accumulation fund and housing subsidy policies, and improves the subsidy standards for low-rent housing. Based on the market-oriented economic system, the policy orientation and model positioning of public rental housing have been established. The combination of government guarantees and market regulation has been implemented. The dual drive of improving people’s livelihood and economic development is to adhere to legal construction and constantly improve the affordable housing management system. Further, the organization and management of housing security is improved and strengthened. In

accordance with government guidelines and the principle of market operations, the housing conditions of the most difficult people in the city are effectively improved.

Scope rules

Most of the economically affordable housing in Hangzhou located far from the urban area. The development and construction of these suburban areas are decided by the way of “living priority”, with a lack of employment opportunities. People usually need to find jobs in the downtown area and the “job and living space mismatch” phenomenon will inevitably arise. This part of the low-income families have to bear the high cost of time and money for transportation to work. This remote location and large-scale construction intensified the low-income groups in the suburbs, forming residential differentiation, resulting in the isolation of the social class. In addition, lack of infrastructure is a major problem for these affordable house.

In Hangzhou, nearly all affordable housing blocks are lacking facilities, and among them some blocks suffer construction lag (such as the educational facilities of Xiangfu block , medical facilities of Ding Qiaodong block), and there are some blocks facing no land to build (Such as educational facilities of Shiqiao Block). As a result of the rapid rise of land acquisition fee, demolition and relocation costs, in order to control cost to make more profits, some developers give short weight in the planning, design, construction and cut corners in engineering aspects, which has a greatly impact on the housing quality. At the same time, economically affordable housing is monotonous in house type and layout, without the careful design of developers. Public facilities within the imperfect public space, seriously affected the comfort of the house.

In view of the problems and disadvantages in the construction of affordable housing, the development of affordable housing in Hangzhou gradually transfer from the economically affordable housing to public rental housing. The construction standards and level is also rising. As shown in Table 3, it can be seen that the living conditions, traffic conditions and the surrounding public service facilities of Hangzhou municipal public rental housing projects are gradually increasing.

Table 3 Hangzhou municipal public rental housing projects

Projects	Infrastructure condition
Huayuangang	Only 100 meters from the Hangzhou North Bus Station, mature surrounding commercial facilities , public transport facilities, schools, hospitals and other basic living facilities.
Sanliting	Less than 4 km from the Wulin Square straight line , is the most close to the city center, convenient traffic, the surrounding living facilities are more mature.
Niutian	Adjacent to the Hangzhou Metro Line 1 Jiuhe Road Station, connecting Desheng Expressway, convenient traffic, basic living facilities.
Tangbei	Adjacent to the Metro Business Center, Yintai City Commercial Complex, Wal-Mart and other commercial facilities in close proximity; public transport facilities mature, near the Metro Line site, the traffic is very convenient; the south near Yuhang Tong River, superior landscape; near Zijingang, Zhejiang University Campus, a strong cultural atmosphere.
Qinglong	Near the West Intime, the Incity and other large commercial facilities within a distance of 1 km, convenient transportation and mature facilities.
Jiangcun	Adjacent to the Green Town Xixi Park, the natural landscape is more superior, the surrounding schools, commercial, transportation and other supporting are mature.
Tianyuan	Architectural modeling simple and elegant, arranged high and low scattered, full of changes, and the surrounding environment has a good convergence.

Improvement of housing conditions greatly improved people's living environment and conditions, and enhance their willingness to stay. Both commercial housing and public rental housing can promote contacts and integration between different groups, to avoid the social isolation.

Payoff rules

From the central to the local, it can be seen that most affordable housing policies are promoted by "notice", "proposal" and and other documents, which lacks legal authority and laws. For the affordable housing land supply, project approval, project construction and sales standards and other issues, there is a lack of the rigid constraints at high-level legislation. The establishment of a comprehensive affordable housing legal system and reward and punishment mechanism need to be promoted.

CONLUSIONS

Facing the times that housing affordability is the key to realize the urbanization of population. This paper combines the characteristics of New-Type Urbanization and provides several constructive guidance and rules in affordable housing policies aimed to enlarge its scope of coverage, in order to greatly enhance the housing affordability in China.

(1) The land supply elements of affordable housing should be strengthened. According to the scope of the population covered by the city's local affordable housing, the ratio of land use for various types of affordable housing should be reasonably arranged to provide a clear and feasible indicator for the construction of the next-stage residential housing. Second, in addition to newly built affordable housing, there are many ways to expand the supplementary ways of housing: such as the transformation of shantytowns and villages in the city, the promotion of shared-property houses, and the reasonable conversion of small-property housing. To ensure the supply of funds for affordable housing, private capital and social capital should be introduced to carry out multi-channel financing to participate in the construction of affordable housing.

(2) The government should take the "Thirteenth Five-Year Plan" as its goal, and further expand the housing guarantee population to non-household populations with residence permits, focus on the agricultural transfer population, and take into consideration the graduates of universities and vocational and technical colleges, and the employment of people from different cities and towns. Also it is necessary to solve the problem of urbanization of newly-transferred agricultural population.

(3) The admission system, exit mechanism and waiting system for affordable housing should be improved. To prevent affordable housing from becoming privileged welfare housing and arbitrage chips, the government can gradually stop the examination and acceptance of economically affordable housing and promote public rental housing and low-rent housing policies.

(4) Governments at all levels must take responsibility, share public costs properly, fully mobilize social forces, and build a citizen-oriented mechanism for transferring agricultural populations that is government-led, multi-participated, cost-sharing, and coordinated. All localities must comprehensively disclose various information on public rental housing, smooth the channels for complaints and supervision, and accept social supervision.

(5) The implementation of affordable housing policies should be based on local conditions in different cities and regions. It is necessary to clarify that housing security should be shifted from brick subsidy to currency subsidy, and local governments should be encouraged to purchase eligible commercial housing as security for housing. In

addition to the form of cash subsidies, monetary subsidies can also include the new mode, such as “housing vouchers” and “rental vouchers”. Through this path, the economic efficiency of the housing rental market can be promoted, and the concept of reasonable housing consumption can be deeply rooted in people’s hearts. Relevant departments can inquire into the relevant policies concerning the allocation of rents and subsidized subsidies for public rental housing so that the rents and subsidies enjoyed by the families can be used more scientifically and reasonably.

(6) Improve the living environment of affordable housing and the surrounding public service conditions. To avoid the marginalization of additional costs and social differentiation phenomenon, TOD mode can be introduced and improved.

(7) The supervision of the construction of affordable housing should be strengthened. The government have the responsibility to realize the goal, prevent the rent-seeking space to produce, speed up the legislation and develop a sound affordable housing law. The establishment of the real estate tax system need to be speeded up, which will enhance the funds supply of affordable housing.

REFERENCES

Lv, P., Xiu, D.P.,& Li, S.(2013). The theory and practice of the common property right model of the affordable housing. *Urban Studies*,20(02):144-148.

Ostrom, E. (2010). Response: the institutional analysis and development framework and the commons. *Social Science Electronic Publishing*, 95(4), 807-815.

Shen, J.H.,Wu, Y.Z.,& Zhang, X.L.(2013). Policy Change from Affordable Housing to Public Rental Housing: A Comparative Analysis Based on IAD Framework, *Proceedings of CRIOCM2013*.

United Nations. (2012). Dept. of Economic and Social Information and Policy Analysis. World urbanization prospects. *United Nations, Dept. of International Economic and Social Affairs*.

Wang, Q. (2010). Evaluation of system analysis and development framework of Ostrom, *Economics Information*, (4)

Wang,W .,&Wu Y.Z.(2016). Research into the Synergy Mechanism of Housing Guarantee and Urban Economic Growth, *JOURNA OF HOHAI UNIVERSITY (PHILOSOPHY AND SOCIAL SCIENCES)*, 2016,18(06):27-33+95.

Wu, H.J. (2009). A Research on the Housing Support Problems of the Migrants During the Movement of Urbanization——Also on the Problem of Striving the Public Rental Housing System, *URBAN STUDIES*,16(12),82-85.

Wu, Y.Z. (2011). Study on the temporal and spatial evolution of urban housing price -- theory, method and Application, *Science Press*

Zhou, S.H., Cheng L.P., &Wu Z.H. (2010). The jobs-housing relocation and spatial matching of residents in alleviatory housing neighborhoods in Guangzhou, *GEOGRAPHICAL RESEARCH*, (10):1735-1745.

THE LINK BETWEEN COMPACT URBAN FORM AND HOUSING AFFORDABILITY IN INDONESIA: WHERE IS THE EMPIRICAL EVIDENCE?

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Abstract
Urban consolidation has become an urban planning and development paradox. One of its recurrent criticisms relates to housing affordability and the role of planning interventions such as compact city policies. Indonesia has adopted the compact city concept in recent years, but there is little knowledge of density's effects. This paper examines whether housing and transport affordability is associated with urban compaction in three Indonesian metropolises. Twenty-two municipalities within Jakarta, Bandung, and the Medan metropolitan areas were studied. National socio-economic survey data were used to measure affordability, while census and statistical data are used to describe the current state of urban compactness in each municipality. Data envelopment analysis (DEA) methods were applied to provide an objective calculation and benchmarking process to evaluate and perform the inter-city comparison of the combined housing and transport affordability. To discover the relationship between affordability and urban compaction this study uses Tobit regression analysis. The results support the argument that urban compaction has a potential to improve housing affordability, particularly when transport and housing costs are combined. The research sheds new light on the link between compact urban form and housing affordability in the developing countries context.

Keywords: Compact city; Housing; Transport; Affordability; Data envelopment analysis (DEA); Indonesia.

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INTRODUCTION

Compact city policies that promote higher densities are being implemented to promote sustainability and limit urban sprawl. Amongst many claimed benefits, compact urban form helps preserve rural and agricultural land (Clark and Tsai 2000; Llewelyn-Davies 1994), lowers car-dependent travel demand, reduces fuel consumption and emissions (Masnavi 2000; Newman and Kenworthy 2000; Thomas and Cousins 1996), and promotes better access to urban services and facilities (Bramley and Power 2009; Burton 2000b; Kaido 2006). On the other hand, disadvantages of such policies include poorer access to green space, increased crime levels, higher risk of respiratory disease, less domestic living space, and lack of affordable housing (Burton 2000b).

Empirical evidence of the link between urban compaction and sustainability is inconclusive. The most ambiguous is the claim that the compact city is socially equitable (Burton 2003). Housing is, perhaps, the area in urban planning that has the greatest social effects (Levy 2003). It has been suggested that some urban compaction strategies (e.g. urban growth boundaries) will limit developable land and housing supply, thereby increasing housing prices and reducing affordability (Addison et al. 2013). Yet, several studies have revealed that policies such as growth boundaries had no significant impact on housing prices (Downs 2002; Jun 2006; Phillips and Goodstein 2000). Higher land prices in contained urban areas should not harm affordability providing housing supply and demand is balanced. Furthermore, recent research contends that true affordability is not merely based on housing cost (CTOD and CNT 2006). Incorporating transport cost in housing affordability calculations produces a more accurate portrait of a household's burden in fulfilling their housing needs and suggests that affordability decreases as the distance from the city centre increases (Buchanan et al. 2005; Haas et al. 2006; Vidyattama et al. 2012; Yates and Gabriel 2006).

Despite the multifaceted relationships between urban form and sustainability, cities with compact urban form are often perceived as more sustainable than dispersed cities. On these grounds, political support for implementing compact development policy is evidenced in both developed and developing countries (Burton 2000b; Burton et al. 1996; Jenks and Burgess 2000). Thus, it is important to consider the implementation of compact city policy in the context of emerging economies. In this regard, Indonesia—the fourth most populous country in the world— is a useful location to explore relationships between compaction, housing and transport affordability. Distinct differences exist between Indonesian cities and Western cities. In Indonesia, the existing population density is already high, urban infrastructure investments are limited, a high level of mixed land-use is apparent, and there is a combination of low mass public transport use and high motorcycle use.

This paper examines whether urban compaction affects overall housing affordability in the three Indonesian metropolitan regions of Jakarta, Bandung, and Medan. The objective is twofold: (1) to analyse housing and transport affordability, and (2) to examine whether greater compactness relates to housing and transport affordability. We use the data envelopment analysis (DEA) method to measure and perform an inter-city comparison of housing and transport affordability. To discover the relationship between affordability and compactness, this study uses the Tobit regression analysis. The structure of this paper consists of five sections. Section 2 provides an overview of the three selected case studies. Section 3 explains the research design and methodology, and the discussion of research findings is in section 4. Section 5 outlines the contributions, as well as research limitations and potential future research.

URBAN FORM, HOUSING AND TRANSPORT IN INDONESIAN METROPOLISES

The three case studies of the Jakarta Metropolitan Area (JMA), Bandung Metropolitan Area (BMA), and Medan Metropolitan Area (MMA) were among metropolitan areas listed as the national strategic area (KSN) in Indonesia. The JMA represents the megalopolis, with its greater than 10 million population; the BMA a large metropolitan area (5–10 million population); and the MMA a metropolitan area with (<5 million population) (World Bank, 2012). The JMA comprises of 13 municipalities (5 in the core, 8 in the periphery), while the BMA comprises of 5 municipalities (2 in core, 3 in the periphery) and the MMA of 4 municipalities (1 in core, 3 in the periphery).

As one of the largest countries by population, Indonesia faces a rapid urbanisation. The proportion of urban dwellers in Indonesia has increased significantly from only 22.3% in 1980 to 30.9% in 1990, 42% in 2000, and 49.8% in 2010 (Badan Pusat Statistik 2002, 2010). Rapid development and urban area expansion is evident in both the JMA and BMA, with the MMA also expanding, albeit at a slower pace. In recent years, Indonesia has adopted the compact city approach to curb urban sprawl; yet, no city in Indonesia can be categorised as a compact city. Populations in the peri-urban areas increase faster than within the cores. (Kustiwan 2010; Winarso et al. 2015; World Bank 2012). New forms of settlement are also apparent, with density in suburban locations more common. A recent study of land use changes in the JMA demonstrated that over 2012–2017, the growth of high-density settlement shifted to the outer areas, where municipalities such as Tangerang, Bogor, and Bekasi Regencies experienced growth rates about three to four times higher than Jakarta in the core (Wahyudi et al. 2018). The trend towards mixed-use and higher density development occurs not only in the city centre but also in suburban areas, particularly in the JMA and BMA. This development creates a more polycentric metropolitan region (Winarso, 2011). The JMA, BMA and MMA demographic profile are presented in Table 1.

Table 1. JMA, BMA and MMA demographic profile

	JMA	**BMA**	**MMA**
Total Area (sq.km)	6,427.51	3,540.50	3,056.97
Population in 2016	32,409,811	8,737,977	4,666,776
Density (person/sq.km) in 2016	11,330	6,970	1,527
Population Growth from 2010-2015 (% /year)	2.27	1.23	1.68
Density Change from 2010-2015 (% /year)	2.11	1.24	1.53
Number of municipalities	13	5	4

Source: Census of Population (2010), Jakarta in Figure (2017), West Java in Figure (2017), Banten in Figure (2017), North Sumatera in Figure (2017)

A large numbers of houses in Indonesian cities are single-family structures (detached and semi-detached), while the trend in new dwelling stock is towards more apartments and flats. Unlike the houses in Western countries, Indonesia's single-family houses do not always occupy a large parcel of land, with land size as minimal as 21 m^2. In terms of transport, the current systems have not kept pace with rapid urban development and expansion. Traffic congestion is a serious problem, caused by a combination of large number of commuting trips, inadequate mass public transit, high dependency on private vehicles, and low road capacity (Susilo and Joewono 2017). Transport mode shares in Indonesia's major cities including the JMA, BMA, and MMA are characterised by a large proportion of private vehicles, especially motorcycles, and a large share of paratransit.

METHODOLOGY

The analysis was carried out in two stages. First, levels of combined housing and transport affordability for the three regions were measured using the DEA method, which provides an objective ratio and benchmarking. In the second stage, Tobit regression was used to identify any relationship between urban compaction and affordability of housing and transport.

Housing and Transport Affordability using Data Envelopment Analysis (DEA)

While studies examining housing and transport affordability generally apply the cost/income ratio method, which is easy to comprehend, they could provide better insights by using more advanced and complimentary measures for affordability calculation and comparison. This paper introduces the Data Envelopment Analysis (DEA) method to measure and rank housing and transport affordability. DEA is a non-parametric efficiency measurement method developed by Charnes, Cooper, and Rhodes, and originally designed to evaluate the relative efficiency of a set of peer entities called decision-making units (DMUs) performing similar tasks (Cook and Zhu 2005). DMU is generic and flexible, allowing units such as firms, governments, cities or regions to be observed (Cook and Zhu 2008). DEA employs linear programming to estimate relative efficiency based on the ratio of weighted outputs to weighted inputs with value ranges from 0 to 1:

$$\text{Efficiency} = \frac{sum\ of\ weighted\ outputs}{sum\ of\ weighted\ inputs}$$

Outputs are those factors we usually try to maximise (e.g., profit, income, etc.), while inputs are those factors we usually try to minimise (e.g. costs, personnel, etc.). The first widely applied DEA model (CCR version), which had an input orientation and assumed constant return to scale, is used. By using the DEA model, this study examined the performance in terms of affordability (labelled as ‘efficiency’ in a DEA framework) of the 22 municipalities. Each municipality was treated as a DMU and the efficiency was measured as affordability. The evaluation results then indicate which municipality is ‘efficient’ or, in this case, ‘affordable’. Table 2 presents the input and output variables for the DEA housing and transport affordability model, and Table 3 presents the descriptive statistics of the variables used in the DEA models.

The advantage of using DEA is that no prior assumption needs to be assigned (i.e. weight) as is done in the simple ratio method, which gives an equal weight setting to both expenditure and income. In DEA, each DMU is assigned with an optimum weight and compared to measure the relative efficiency. Thus, DMUs with the best combination of inputs and outputs are the most affordable locations, relative to others, included in the observation. The best performing DMUs will generate the frontier line and be set as the benchmark for ranking the affordability level of other locations in the observation area. As the benchmark, these DMUs are set as the reference (peer) against which other DMUs may improve their affordability level.

Application of DEA requires that the functions relating inputs to outputs have the mathematical property called isotonicity (Banker et al. 1989; Bowlin 1998; Charnes et al. 1985), which means that an increase in any input should result in an increase in output, or in having a positive correlation. Correlation analysis results for the dataset show that all correlation coefficients are significantly positive, suggesting that the data satisfies the isotonicity property.

Table 2. Input and output variables for DEA housing and transport affordability

Variables			
Input		**HOUSING COSTS**	
	1	RENT	Rental cost for both renter and owner-occupied houses
	2	O&M	Operational and maintenance costs: • Utility cost (electricity, water, gas, LPG, etc.) • Minor repairs and maintenance cost • Neighbourhood maintenance fee
		TRANSPORT COSTS	
	3	FUEL	Fuel cost
	4	OIL	Engine oil/lubricant cost
	5	REP	Vehicle maintenance and minor repairs cost
	6	PT*	Public transport and other costs
Output		**HOUSEHOLD INCOME**	
	1	EXP**	Total household expenditure (incl. food and non-food consumption, taxes and insurances, but not savings)

* PT covers expenses from public transport fares (incl. airplane), parking fees, tolls, and other costs. This aggregation has made it impossible to exclude long-trip and non-daily travel, and to separate the private and public transport costs.
** The Indonesian Bureau of Statistics (BPS) could not release household income data, thus total household expenditure is used as a proxy for income.

Table 3. Descriptive Statistics of the Inputs and Outputs Variables for DEA Models (in Indonesian Rupiahs)

Variables			Mean	Minimum	Maximum	Std. Dev.
Input	Housing Cost	RENT	440,681.82	138,000.00	747,000.00	188,265.11
		O&M	171,850.00	85,000.00	260,000.00	51,909.81
	Transport Cost	FUEL	145,200.00	65,000.00	232,000.00	41,048.23
		OIL	34,204.55	30,000.00	41,000.00	2,594.22
		REP	42,713.64	25,000.00	69,000.00	10,496.45
		PT	88,045.45	30,000.00	140,000.00	27,703.32
Output	Total Expenditure	INC	3,174,335.02	1,460,952.38	4,636,116.33	867,532.20

1 USD = 13,769.57 IDR (in 2018)

The link between urban compaction and affordability using Tobit regression

Tobit regression modelling was used to further identify the relationship between urban compaction and the DEA results of H+T affordability. The Tobit model, also known as a censored regression model, is often used to further analyse DEA results (Merkert and Hensher 2011; Mujasi et al. 2016) because it is designed to estimate linear relationships between variables with a censored dependent variable. Based on the literature and available data and information, there are six urban compaction indicators included in the model, which represent density and mix-use attributes of the approach. Density is represented by household density (HHDENS), high-density/small-sized housing (SHOUSE), job concentration (JOBDENS), and road density (ROADENS). Mix-use is represented only by the provision of key facilities: number of education facilities in an

area (EDU), and urban services as in proportion of household with water access (WATER), due to data limitations.

It is assumed that urban compactness potentially maintains or promotes housing affordability, thus positive signs were expected for all compact city indicators that were selected as the regressor. In addition, we included one binary variable, 'CORE', representing whether the municipality is located in the core of the metropolitan area. Given their concentration of population, jobs, and key urban facilities, it is assumed that core areas have greater compactness than peripheries, thus a positive sign is expected.

RESULTS AND DISCUSSIONS

Housing and Transport Affordability in the JMA, BMA, and MMA

Results obtained from the DEA model are displayed in Table 4. They show that for housing affordability, only Karo Regency in the peripheries of the MMA and Depok City in the peripheries of the JMA are considered as 'affordable' compared to others being observed, with a DEA score of 1.00. The results suggest that housing cost spent by households in these municipalities are relatively affordable for their given income. The least affordable is North Jakarta city in the core of the JMA. The results in the MMA support both location theory and previous studies suggesting that outlying areas are more affordable than the city core (Isalou et al. 2014; Mattingly and Morrissey 2014). This is not completely the case in the JMA and BMA; some municipalities in the peripheral areas are less affordable than in the core areas, for example, South Tangerang and Tangerang City in the JMA. This outcome may be explained by the privatisation process of the peripheral areas in metropolitan Jakarta. Suburban development in the JMA is greatly influenced by the private sector; one example is the development of the "residential new town", responding to the demands of middle- and high-income groups (Firman and Fahmi 2017). Bumi Serpong Damai (BSD) in South Tangerang City is the largest of this kind in the JMA, and is mostly comprised of gated communities with international standard urban public facilities and amenities. In recent years, BSD and other residential new towns on the fringe of metropolitan Jakarta have turned into more independent new towns with strong economic bases, and are becoming the new urban centres in the peripheries (Firman and Fahmi 2017; Winarso et al. 2015).

The transport affordability model produces higher affordability scores than that of housing, with an average of 0.917. Nine municipalities are 'transport affordable'; six of these are located in the JMA. This result shows that the JMA is more affordable in terms of transport, probably due to broader mass public transport options for its residents, such as the bus rapid transit system (Trans Jakarta) and the commuter trains that connect the periphery to the core areas. Affordability scores in the JMA varied across the core and periphery areas, which may be related to findings from previous studies suggesting that metropolitan Jakarta has turned from a monocentric into a multicentric metropolitan region (Firman and Fahmi 2017; Hakim and Parolin 2009; Winarso et al. 2015). Meanwhile, the monocentric pattern is more observable in the BMA and MMA, where transport affordability decreased as the distance from the core areas increased.

When combined, the overall affordability scores show the influence of transport costs. Incorporating transport costs into housing affordability measurement reveals the true affordability and cross subsidy effect between housing and transport costs. In many cases, municipalities with low housing affordability score better when transport costs are included. Thirteen municipalities are considered as affordable and the lowest affordability score is 0.810, which is higher than the average of the housing affordability scores, at 0.619. Often, households try to optimise their budget by choosing to live in a higher

housing-price area (e.g., the inner city) to reduce their transport costs and vice versa. This trade-off can be seen in the case of Central Jakarta, Bandung, and Medan City, as well as Bogor and Tangerang Regency. The first three municipalities have relatively lower housing affordability, and were at the bottom of the affordability ranking (18th, 15th, and 17th respectively). However, these are the core cities of the metropolitan areas, which theoretically have better transport options and accessibility, and thus 'transport affordable" (DEA scores of 1.00). The transport cost has offset their high housing cost burden, so at the combined affordability ranking the three cities perform better (ranked 1st) and are considered as affordable locations. On the other hand, households living in Bogor and Tangerang Regency are considered as having a lower housing cost burden because these municipalities ranked 2nd and 3rd in affordability ranking, yet are regarded as worse-off in terms of transport (ranked 13th and 11th) compared to other municipalities. The cross-subsidies between housing and transport costs are captured by the DEA calculation revealed in the combined affordability ranking where Tangerang Regency is considered an affordable municipality, with DEA scores of 1.00, and where Bogor Regency ranked fourth.

Table 4. DEA affordability scores

Metropolitan Area		**Municipalities**	**Housing Affordability**	**Transport Affordability**	**H+T Affordability**
JMA	Core	South Jakarta	0.852	1.000	1.000
		East Jakarta	0.816	0.976	1.000
		Central Jakarta	0.742	1.000	1.000
		West Jakarta	0.816	1.000	1.000
		North Jakarta	0.684	0.873	1.000
	Peripheries	Tangerang Regency	0.910	0.825	1.000
		Tangerang City	0.841	1.000	1.000
		South Tangerang City	0.695	1.000	1.000
		Bogor Regency	0.942	0.707	0.949
		Bekasi Regency	0.889	1.000	1.000
		Bogor City	0.831	0.852	0.963
		Bekasi City	0.763	0.892	0.893
		Depok City	1.000	0.994	1.000
BMA	Core	Bandung City	0.755	1.000	1.000
		Cimahi City	0.872	0.864	1.000
	Peripheries	Bandung Regency	0.828	0.727	0.890
		West Bandung Regency	0.754	0.928	0.943
		Sumedang Regency	0.784	0.855	0.879
MMA	Core	Medan City	0.751	1.000	1.000
	Peripheries	Binjai City	0.771	0.706	0.969
		Deliserdang Regency	0.830	0.977	1.000
		Karo Regency	1.000	1.000	1.000
Average			0.824	0.917	0.977

Compaction and Affordability: are they linked?

The outcomes of the Tobit model revealed the influence of urban compaction on combined housing and transport affordability. A positive correlation was found between five attributes of urban compaction and the overall affordability, as expected. This result is statistically significant at the p = 0.01 level (HHDENS, SHOUSE, JOBDENS) and p = 0.10 level (EDU, WATER). On average, a one unit increase in household density (HHDENS), proportion of high-density houses (SHOUSE), job opportunities (JOB), education facilities (EDU), and proportion of households with piped water access (WATER) will lead to an increase of location affordability by 8.55%, 1.64%, 98.33%, 4.14% and 0.45%, respectively. Two variables, ROADENS and CORE, have negative coefficients that are significant at the p = 0.10 level. The coefficient of ROADENS indicates that a one unit increase in road density will decrease the affordability score by 3.77%, while according to the associated estimated parameter, CORE makes a negative contribution to affordability, which means that municipalities located in the core areas are less affordable. The standardised estimates show that centrality (CORE) has the biggest influence on the combined housing and transport affordability, while the house size has the least.

Table 5. Results of Tobit model

Regressor	Coefficient	Standardised Coefficient	z value [b]
Constant	–0.3709***[a]	–0.1350***	–3.684
HHDENS	0.0855***	0.1429***	2.585
SHOUSE	0.0164***	0.0174***	2.734
JOBDENS	0.9833***	0.0554***	2.960
ROADENS	–0.0377***	–0.1745***	–3.023
EDU	0.0414*	0.0355*	1.845
WATER	0.0045*	0.0589*	1.861
CORE	–0.5640***	–0.2776***	–4.615
Sigma = 0.034196 (0.00849182)		Log-likelihood = 10.71310	
Akaike criterion = –3.426203			
No. of obs. = 22		Left-censored observations = 15	

[a] (***) and (*) indicate the significance of the estimates at the 1% and 10% levels, respectively.
[b] The Z-statistic of the parameter estimates

Density features of urban compaction represented by gross household density (HHDENS) and proportion of small-sized houses (SHOUSE) indicate that higher density may promote overall housing affordability: the higher the residential density and the proportion of small-sized housing, the more likely housing and transport within cities in the JMA, BMA, and MMA to become more affordable. This finding supports the arguments that high-density cities have a potential to ensure housing affordability by using less-space and increasing density for accommodating their population (Aurand 2010; Downs 2002). In a country like Indonesia, where land is one of the main determinants of housing prices (Davis and Heathcote 2007; Kok et al. 2014; Winarso 2002), it can be suggested that efficient use of the land promoted by urban compaction (e.g. higher-density and vertical housing development) should be pursued to ensure the affordability of housing in an area. Furthermore, the estimated parameter for JOBDENS indicates that affordability would increase as the number of job opportunities within municipalities increase. It seems possible that this result is due to reduced household

travel expenses that might occur from shorter travel to work in municipalities with greater job opportunities.

The “mix of uses” features of the compact city approach as represented by the provision of education facilities (EDU) and water services (WATER) further supports the arguments that suggest a positive relationship between greater compactness and affordability. As the number of education facilities in a city increases, it is more likely residents will satisfy their daily travel to schooling and higher education within the vicinity, thus lowering their transport expenditure. It can also be seen that living in a house that has an urban piped water service provided by the city-owned enterprise (known as PDAM) positively influences the affordability of housing. This urban piped water service is mostly concentrated in central and high-density areas. Households living outside the PDAM service area have to acquire water from different sources which in some cases consumes more of their budget.

Contrary to expectations, this study found a negative relationship between ROADENS as a proxy of accessible location and combined housing and transport affordability. The estimated parameter suggests that municipalities with better (road) access are less affordable. Road infrastructure provision in Indonesia is still heavily concentrated in major cities within the main island of Java. As one of the main indicators of urban development, the economic value of having a better road network will drive land values up, which then influences housing prices and affordability. On the other hand, the expected reduction of transport cost from higher accessibility is insufficient to outweigh housing cost and so increase the combined H+T affordability. Because public transport systems in Indonesian cities are relatively substandard, more roads often mean more private vehicles, which might be an influence on household’s travel behaviour and transport expenses. For a similar reason, this inconsistent result applies to the last explanatory variable, CORE. Although the observed affordability scores show that the combined affordability scores are better in the core areas, the regression estimates indicate the opposite. It seems that, generally, core areas are still too expensive; the advantage of having better access and broader affordable transport options such as reliable public transport, walking, and cycling may not outweigh housing costs for households living in these areas. Density appears to have advantages, but we cannot say definitively that living in the core offers the same.

CONCLUDING REMARKS

This study’s main contributions are methodological, being one of the first attempts to measure affordability using the data envelopment analysis (DEA) method and to further explore whether it is linked with several attributes of urban compaction. This study was designed to examine housing and transport affordability in three Indonesian metropolitan regions and its association with urban compactness. The overall affordability results demonstrate a cross-subsidy effect between housing and transport expenses, as households in the JMA, BMA, and MMA try to find the most efficient combination of their budget spending. Findings on the relationship between compactness and affordability are consistent with the arguments that the compact city approach has a potential to improve housing affordability, particularly when transport and housing costs are combined.

However, the generalisability of these results is subject to certain limitations because the observed variables for urban compaction in this study do not comprehensively represent the concept. The variables applied are far from exhaustive, but limited by comparable publicly available data for the three metropolises. To identify the influence of the compact city concept on housing affordability more precisely, an in-depth

investigation in a single case study is recommended, because issues such as different format and base year of spatial and statistical data in Indonesia are profound. A questionnaire-based survey on urban compaction attributes is a plausible approach to gaining supplementary data.

The findings of this study also have a number of practical implications. This study suggests that complementary strategies are needed to guide the application of compact city policy within Indonesia to ensure housing affordability. The higher-density housing program, such as vertical housing, should be strengthened, as well as key urban facilities and infrastructure provision. The regression results of road infrastructure imply that it is important to also focus on a non road-based transport system network, such as rail-based mass public transport, which may assist in promoting transport affordability in a compact urban form.

REFERENCES

Addison, C., Zhang, S., and Coomes, B. (2013) Smart growth and housing affordability: A review of regulatory mechanisms and planning practices. *Journal of Planning Literature, 28*(3), 215-257. doi:10.1177/0885412212471563

Aurand, A. (2010) Density, housing types and mixed land use: Smart tools for affordable housing? *Urban Studies, 47*(5), 1015-1036.

Badan Pusat Statistik (2002). *The Result of population census 2000*. Retrieved from www.bps.go.id

Badan Pusat Statistik (2010). *Census of population*. Retrieved from: www.bps.go.id

Banker, R. D., Charnes, A., Cooper, W. W., Swarts, W., & Thomas, D (1989) An introduction to data envelopment analysis with some of its models and their uses. *Research in Governmental and Nonprofit Accounting, 5*(1), 125-163.

Bowlin, W. F. (1998) Measuring performance: An introduction to data envelopment analysis (DEA). *The Journal of Cost Analysis, 15*(2), 3-27. doi:10.1080/08823871.1998.10462318

Bramley, G., and Power, S. (2009) Urban form and social sustainability: the role of density and housing type. *Environment and Planning B: Planning & Design, 36*(1), 30-48. doi:10.1068/b33129

Buchanan, N., Evans, R., and Dodson, J. (2005) Transport disadvantage and social status: A Gold Coast pilot project. *Research Monograph, 8*.

Burton, E. (2000) The potential of the compact city for promoting social equity. In E. Burton, M. Jenks, and K. Williams (Eds.), *Achieving sustainable urban form* (pp. 19-29). Spon Press, London.

Burton, E. (2003) Housing for an urban renaissance: Implications for social equity. *Housing Studies, 18*(4), 537-562.

Burton, E., Jenks, M., and Williams, K. (1996) *The compact city: a sustainable urban form?* E&F.N. Spon, London.

Charnes, A., Cooper, W. W., Golany, B., Seiford, L., and Stutz, J. (1985) Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical production functions. *Journal of econometrics, 30*(1-2), 91-107. doi:10.1016/0304-4076(85)90133-2

Clark, T. A., and Tsai, T.-I. A. (2000) The agricultural consequences of compact development; The case of Asian Cities. In M. Jenks & R. Burgess (Eds.), *Compact Cities : Sustainable Urban Forms for Developing Countries*. Spon Press, London.

Cook, W. D., and Zhu, J. (2005) *Modeling performance measurement: Applications and implementation issues in DEA*. Springer, New York.

Cook, W. D., and Zhu, J. (2008) *Data envelopment analysis: Modeling operational processes and measuring productivity*. Create Space Independent Publishing Platform, Lexington.

CTOD and CNT. (2006) The affordability index: A new tool for measuring the true affordability of a housing choice. Retrieved from www.brookings.edu/wp-content/uploads/2016/06/20060127_affindex.pdf

Davis, M. A., and Heathcote, J. (2007) The price and quantity of residential land in the United States. *Journal of Monetary Economics, 54*(8), 2595-2620. doi: https://doi.org/10.1016/j.jmoneco.2007.06.023

Downs, A. (2002) Have housing prices risen faster in Portland than elsewhere? *Housing Policy Debate, 13*(1), 7-31. doi:10.1080/10511482.2002.9521432

Firman, T., and Fahmi, F. Z. (2017) The privatization of Metropolitan Jakarta's (Jabodetabek) urban fringes: The early stages of "Post-Suburbanization" in Indonesia. *Journal of the American Planning Association, 83*(1), 68-79. doi: https://doi.org/10.1080/01944363.2016.1249010

Haas, P. M., Makarewicz, C., Benedict, A., Sanchez, T. W., and Dawkins, C. J. (2006) Housing and transportation cost trade-offs and burdens of working households in 28 Metros. Retrieved from http://www.centerforhousingpolicy.org/media/documents/chp-pub-h106-cnt-report.pdf

Hakim, I., and Parolin, B. (2009) Spatial structure and spatial impacts of the Jakarta metropolitan area: A South East Asian EMR perspective. *International Journal of Human and Social Science, 4*(2), 397-405.

Isalou, A. A., Litman, T., and Shahmoradi, B. (2014) Testing the housing and transportation affordability index in a developing world context: A sustainability comparison of central and suburban districts in Qom, Iran. *Transport Policy, 33*, 33-39. doi: https://doi.org/10.1016/j.tranpol.2014.02.006

Jenks, M., and Burgess, R. (Eds.). (2000) *Compact Cities : Sustainable Urban Forms for Developing Countries*. Spon Press, London.

Jun, M.-J. (2006) The effects of Portland's urban growth boundary on housing prices. *Journal of the American Planning Association, 72*(2), 239-243. doi:10.1080/01944360608976742.

Kaido, K. (2006) Urban densities, quality of life and local facility accessibility in principal Japanese cities. In M. Jenks and N. Dempsey (Eds.), *Future forms and design for sustainable cities. Oxford*. Elsevier, London.

Kok, N., Monkkonen, P., and Quigley, J. M. (2014) Land use regulations and the value of land and housing: An intra-metropolitan analysis. *Journal of urban Economics, 81*, 136-148. doi: https://doi.org/10.1016/j.jue.2014.03.004

Kustiwan, I. (2010) *Sustainable Urban Form and Development (Study of Potencies of Urban Compaction at Bandung Metropolitan Area).* (PhD), Universitas Indonesia.

Levy, J. M. (2003) *Contemporary urban planning* (6 ed.), Prentice Hall, Upper Saddle River, N.J.

Llewelyn-Davies. (1994) *Providing more homes in urban areas*. SAUS Publications, Bristol.

Masnavi, M.-R. (2000) The new millennium and the new urban paradigm: The compact city in practice. In E. Burton, M. Jenks, and K. Williams (Eds.), *Achieving sustainable urban form* (pp. 64-73). Spon Press, London.

Mattingly, K., and Morrissey, J. (2014) Housing and transport expenditure: socio-spatial indicators of affordability in Auckland. *Cities, 38*, 69-83. doi:https://doi.org/10.1016/j.cities.2014.01.004

Merkert, R., and Hensher, D. A. (2011) The impact of strategic management and fleet planning on airline efficiency–A random effects Tobit model based on DEA efficiency scores. *Transportation Research Part A: Policy and Practice, 45*(7), 686-695. doi:https://doi.org/10.1016/j.tra.2011.04.015

Mujasi, P. N., Asbu, E. Z., and Puig-Junoy, J. (2016) How efficient are referral hospitals in Uganda? A data envelopment analysis and tobit regression approach. *BMC health services research, 16*(1), 230. doi:10.1186/s12913-016-1472-9

Newman, P., and Kenworthy, J. (2000) Sustainable urban form: The big picture. In E. Burton, M. Jenks, and K. Williams (Eds.), *Achieving sustainable urban form* (pp. 109-120). Spon Press, London.

Phillips, J., and Goodstein, E. (2000) Growth management and housing prices: the case of Portland, Oregon. *Contemporary Economic Policy, 18*(3), 334-344. doi:10.1111/j.1465-7287.2000.tb00030.x

Susilo, Y. O., and Joewono, T. B. (2017) Indonesia. In D. Pojani & D. Stead (Eds.), *The urban transport crisis in emerging economics* (pp. 107-126). Springer International Publishing, Switzerland.

Thomas, L., and Cousins, W. (1996) The compact city: A successful, desirable and achievable urban form. In E. Burton, M. Jenks, & K. Williams (Eds.), *The compact city: A sustainable urban form* (pp. 53-65), Spon Press, London.

Vidyattama, Y., Tanton, R., and Nepal, B. (2012) The effect of transport costs on housing-related financial stress in Australia. *Urban Studies, 50*(9), 1779-1795. doi:10.1177/0042098012468342

Wahyudi, A., Liu, Y., and Corcoran, J. (2018) Combining Landsat and landscape metrics to analyse large-scale urban land cover change: A case study in the Jakarta Metropolitan Area. *Journal of Spatial Science*, 1-20. doi:10.1080/14498596.2018.1443849

Winarso, H. (2002) Access to main roads or low cost land? Residential land developers' behaviour in Indonesia. *Bijdragen tot de Taal-, Land- en Volkenkunde,, 158*(4), 653-676.

Winarso, H. (2011) Urban dualism in the Jakarta Metropolitan Area. In A. Sorensen & J. Okata (Eds.), Megacities: urban form, governance, and sustainability (pp. 163-191). Springer Japan, Tokyo. doi: http://dx.doi.org/10.1007/978-4-431-99267-7_8.

Winarso, H., Hudalah, D., and Firman, T. (2015) Peri-urban transformation in the Jakarta Metropolitan Area. *Habitat International, 49*, 221-229.

World Bank. (2012) *Indonesia - The rise of metropolitan regions : towards inclusive and sustainable regional development.* Retrieved from: http://documents.worldbank.org/curated/en/2012/08/16587797/indonesia-rise-metropolitan-regions-towards-inclusive-sustainable-regional-development

Yates, J., and Gabriel, M. (2006) Housing affordability in Australia. *National Research Venture 3 : Housing affordability for lower income Australians: Vol. 3*: Australia Housing and Urban Research Institute.

IMPROVING PUBLIC TRANSPORT INFRASTRUCTURE IN AUCKLAND: WHO WILL BENEFIT?

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Abstract
Whilst investment in public transport infrastructure resulting in faster, more frequent and reliable public transport options to suburbs currently reliant on cars and buses is to be welcomed, the potential for property price increases, gentrification and / or displacement of residents and businesses in the areas surrounding the rail stations is of concern. Using a case study of Auckland's City Rail Link (CRL), currently under construction, the research identifies 'at risk' suburbs along Auckland's western and southern rail lines. The research hypothesises that the vulnerability to gentrification and / or displacement may be increased by significant residential up-zoning, across many of the areas adjacent to transport nodes, in the statutory Auckland Unitary Plan (2017). Considerations of policy interventions to mitigate potential social impacts of the City Rail Link are notably absent in the New Zealand policy arena in general, and in the Auckland Council's CRL urban planning and transport documents in particular.

Keywords: Public transport investment; Gentrification; Policy interventions.

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INTRODUCTION

Transport in Auckland is dominated by private vehicles, with resulting high per capita greenhouse gas emissions that contribute to climate change. Auckland is starting to transition to a lower carbon city, with a commitment from Government and the Auckland Council to build the City Rail Link (CRL), at a cost of $3.4 billion (City Rail Link Ltd., 2017). When completed in 2023, the CRL will provide more reliable, faster and frequent public transport options to suburbs that are currently reliant on cars and buses. Whilst investment in such public transport infrastructure is to be welcomed, the potential for property price increases, gentrification and / or displacement of residents and businesses in the areas surrounding the rail stations is of concern.

This research hypothesises that the CRL is a significant investment in public transport infrastructure which will trigger property price increases and gentrification of the areas surrounding train stations. If gentrification occurs both commercial businesses and lower-income residents are likely to be displaced. Similar processes following investment in public transport infrastructure have been identified in San Francisco, Sydney and London.

The first part of the paper reviews the international academic and policy literature: to provide an overview of the evidence for property price uplift following public transport investment, and the impact of this for existing residents and businesses; and to identify the range of policy tools that have been used in attempts to mitigate these impacts. Using a case study of Auckland's CRL, the research considers 'at risk' suburbs along Auckland's western and southern rail lines. In addition to the new substantial public transport investment, the paper queries whether vulnerability to gentrification and / or displacement may be increased by significant residential up-zoning, across many of the areas adjacent to transport nodes, in the 2016 statutory Auckland Unitary Plan (AUP). The final section turns to a consideration of possible policy interventions to mitigate the impact of property price uplift arising from public transport investment, and the New Zealand policy arena is explored, seeking the presence of potential interventions.

PUBLIC TRANSPORT INVESTMENT AND SOCIAL EQUITY: THE LITERATURE

The hypothesis of this research project is that public transport investment triggers land value increases due to improved accessibility. This hypothesis is broadly supported by the existing body of research evidence. There are two strands of theory behind the research evidence: the first is urban structure and accessibility literature; the second is gentrification and displacement literature. This brief review will focus on research that includes both elements – how transport infrastructure investment changes accessibility and how this change relates to gentrification and displacement.

There are numerous studies from a range of countries that quantify the land value uplift from public transport investment. This is often termed 'betterment'. Research quantifying value uplift from public transport projects has been undertaken for a number of United States and Australian cities (e.g. Baker, 2017). Anticipatory value uplift preceding the transport investment has also been considered for several North American cities including the Metro Green Line, Minnesota (Cao & Porter-Nelson, 2016).

A smaller number of studies have specifically related public transport investment, value uplift and gentrification. LeRoy and Sonstelie (1983) use a very long run dataset of socioeconomic statistics and commuting modes in the United States. While this study focused on private vehicles, later research has used it as a model for public transport investment. For example, Lin (2002) used Leroy and Sonstelie's model to test the hypothesis that public transport investment leads to gentrification. He used changes in

residential property values in Chicago to confirm the hypothesis, finding that properties adjacent to transit stations had a 20% value higher increase in value compared to those located half a mile away. Later studies have introduced multiple indicators of gentrification. For example, Kahn (2007) uses property prices and the proportion of college graduates to represent gentrification. He examines 14 major American cities and found that 'gentrification' was greater in communities with easy access to 'Walk and Ride' transit stations than those with 'Park and Ride' transit stations. Lin and Chung (2017) examine the relationship between 'metro-systems' and gentrification in Taipei, Taiwan and conclude that metro-induced gentrification – as measured by residents' education levels and real-estate development activity - was stronger in the outer urban areas, whereas metro-induced gentrification measured by house prices was stronger in inner urban areas. Clearly the choice of indicators is important.

Not all research has found consistent evidence for transit induced gentrification. Baker and Lee (2017) examined the relationship between light rail transit stations and changes in neighbourhood characteristics associated with gentrification for 14 locations in the United States. They found that there were heterogeneous outcomes in different locations, with gentrification in San Francisco, and 'counter-gentrification' in Portland – with lower income residents moving to the areas adjacent to the new transit infrastructure. They conclude that local and regional planning policies for 'inclusive' developments may have mitigated gentrification in some locations.

There is also an emerging body of policy literature and tools on gentrification and public transport infrastructure investment. The Luskin School of Public Affairs (UCLA, 2017) has created an interactive web-based mapping tool to demonstrate the impact of new light-rail and subway projects on low-income communities. There are maps for Los Angeles, the San Francisco Bay Area, and Portland, Oregon. The data shows both where gentrification has occurred and identifies areas vulnerable to gentrification. Locations around transit stations were more likely to gentrify, with increases in the proportion of ethnically white, college educated, and higher income households. Rents also increased in these locations. Additionally, these locations were associated with displacement of disadvantaged populations. Pollack et al.'s policy research (2010) found neighbourhoods adjacent to new transit, with a larger number of renters were more susceptible to gentrification. The University of California's Centre for Community Innovation produced an 'Early Warning Toolkit' to help communities identify whether their neighbourhood is susceptible to gentrification (Chapple, 2009). They use historical gentrification in California in the 1990s to identify 19 factors that had either a positive or negative influence on whether a location gentrified. The availability of amenities and public transportation were the most influential positive factors that made neighbourhoods more likely to experience gentrification.

MITIGATING GENTRIFICATION AND DISPLACEMENT: POLICY TOOLS

The second aim of this paper is to identify the policy tools that have been used to attempt to mitigate the negative impact of public transport investment on surrounding areas. There is a limited body of academic literature on this topic, with a more expansive range of policy and consultancy reports. This also includes research on the potential of 'capturing' the land value uplift from public transport investment to fund the infrastructure itself (Murray, 2017; Peterson, 2008; Viguié & Hallegatte, 2014).

Feinstein and Allen (2011) first examine the effects of the Red Line extension on neighbourhood demographics and housing costs in Boston. They propose a 'Community Benefits Agreement' (CBA) as a tool for mitigating gentrification. CBA is a contract negotiated between community groups and a prospective developer, in which the

developer agrees to provide particular community benefits in exchange for the support of the community. They argue that the Massachusetts Bay Transportation Authority should use its eminent domain powers to transfer land for the construction of affordable housing.

Dawkins and Moeckel (2016) discuss the use of affordable housing policies as part of transit orientated development projects in the United States. Supply side subsidies have been the most successful, however, they also argue that there is limited evidence supporting the effectiveness of policy interventions in mitigating transit induced gentrification. Hickey (2013) discusses the potential of community land trusts (CLTs) to ensure Transit Orientated Development results in housing affordable to lower income households. He finds that CLTs can shape neighbourhood planning and transit decisions if they are put in place early and are able to purchase land before value uplift occurs.

The Community Development Project (2012) produced a guide for Southern California housing advocates to influence affordable housing polices during transit planning. While the legal and institutional context is specific to California, the general range of policy options is of wider applicability. These include: Inclusionary Housing and Density Bonuses; Transit Orientated Development Acquisition Funds, which offer grants or low interest loans to non-profit developers to acquire property for the development of affordable housing around new transit infrastructure; and Transit Orientated Development Overlay Zones, which can incorporate a range of tools including affordable housing requirements. The guide also discusses 'value capture', whereby rising property values as a result of new transport infrastructure are 'captured' in order to help fund public facilities and programs, including affordable housing.

AUCKLAND CITY RAIL LINK: VULNERABILITY FOR SUBURBS LOCATED ALONG THE WESTERN AND SOUTHERN RAIL LINES

The City Rail Link project, once complete, will reduce travel times and increase train frequency from existing train stations in the Auckland rail network to the central city. Given the evidence set out above that transport infrastructure improvement can lead to gentrification in the areas surrounding train stations, we have undertaken a small case study of five neighbourhoods along the Western and Southern train lines, with the aim of assessing their vulnerability to gentrification. In our initial assessment we considered: Household income; Tenure; Housing costs; Potential for redevelopment and Housing stock value. Our hypothesis is that the locations we have selected will be vulnerable to gentrification, on the basis of: household incomes below the Auckland average, percentage of rental tenure above the Auckland average with a higher proportion of tenants paying below the median Auckland rental, and potential for redevelopment due to both zoning that permits higher density housing types and lower housing stock values than the Auckland average.

CASE STUDY LOCATIONS

Auckland's existing passenger rail network (as shown in Figure 1.) consists of four radial lines leading to a central business district terminus 'Britomart'. The City Rail Link project will turn the 'dead end' Britomart station into a loop, with two new central city stations. The CRL will allow trains to run in both directions through Britomart. According to the project's 'benefits' this will double the number of trains on the network, double the capacity of people on trains to 30,000-plus an hour, and double the number of people living within 30 minutes travel of the CBD by increasing train speed and frequency (City Rail Link Ltd., 2017). The five case study stations selected for this paper include two on the Western line (Glen Eden and Ranui), and three on the Southern line (Papatoetoe, Manurewa and Papakura). These are not within the already gentrified inner and eastern

suburbs of Auckland, and they will experience travel time savings when the CRL project is completed. Stations that do fall within these gentrified inner and eastern suburbs include Ellerslie (Southern Line) and Kingsland (Western Line), and we have added these two as comparator stations.

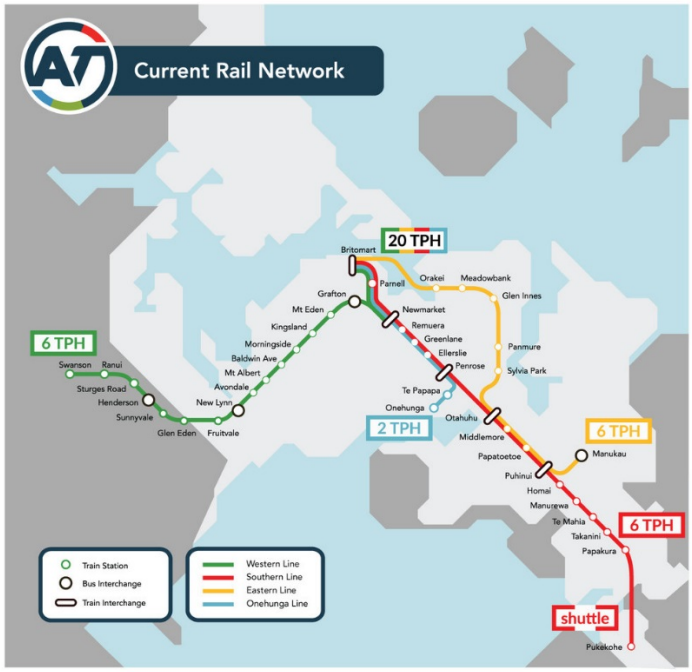

Figure 1. Auckland's current rail network. (City Rail Link, 2017)

The major anticipated benefits of the CRL will be the significant reductions in travel times to the central city from all of the stations. The current frequency of 6 trains per hour along the Western and Southern lines is not anticipated to increase, at this time. (City Rail Link, 2017)

Table 1. Changes in travel time.

	Current travel time by train	Travel time with the completed CRL
Comparator inner stations		
Ellerslie	20 minutes	10 minutes
Kingsland	30 minutes	10 minutes
Case study 'at risk' stations		
Western Line		
Glen Eden	50 minutes	30 minutes
Ranui	60 minutes	40 minutes
Southern Line		
Papatoetoe	40 minutes	30 minutes
Manurewa	50 minutes	40 minutes
Papakura	60 minutes	50 minutes

HOUSEHOLD CHARACTERISTICS

In order to assess household and housing characteristics, we used Area Unit data from the Statistics New Zealand Census (2013). We acknowledge that the profile of our case study areas may have changed since 2013, especially with the rapid house price growth recently

experienced (Chancellor, Abbott, & Carson, 2016). We constructed case study areas surrounding each rail station using Census Area Units, which were assessed to be within a walking catchment of the station (1 km). This delivered varied numbers of households based on the housing density and proportion of non-housing land uses within each catchment (see Table 2)

Table 2. Household characteristics, 2013.

	Number of households	Households income < $50,000	Households who do not own their home	Weekly rent below Auckland median ($350)
Comparator inner stations				
Ellerslie	3,252	23%	41%	38%
Kingsland	1,545	17%	47%	27%
Case study 'at risk' stations				
Glen Eden	2,511	34%	38%	62%
Ranui	1,902	35%	41%	56%
Papatoetoe	4,590	31%	42%	63%
Manurewa	1,335	40%	50%	62%
Papakura	2,559	41%	46%	72%
Auckland	469,500	*28%*	*36%*	*44%*

With the limitations of using 2013 data as a qualification, the analysis indicates all five case study locations have some vulnerability to gentrification. Compared to the Auckland region as a whole, with 28% of households earning below $50,000 per annum, all five of the case study locations had a higher proportion, ranging from 31% in Papatoetoe to 41% in Papakura. The two comparison locations, Ellerslie and Kingsland, had 23% and 17% respectively of households in this category (Statistics NZ, 2013).

All five case study locations and the two comparator locations had higher rates of households that did not own their own home than the Auckland region rate (36%), reaching 50% in Manurewa (one of the five case study locations) and 47% in Kingsland (one of the comparator locations) (Statistics NZ, 2013). Tenure is important because New Zealand's private rental housing sector is characterised by insecurity, lack of affordability, and poor conditions (Eaqub & Eaqub, 2015; Howden-Chapman, 2015). Unlike other jurisdictions where private tenants have a high degree of security, rents can be raised every 6 months, and most tenancies ended with 90 days' notice, or 42 days on sale of the home or for the landlord's own family use (Residential Tenancies Act 1986).

The third variable was the proportion of households who had rental payments below the Auckland median ($350 per week in 2013). This was significantly higher than the Auckland region rate (44%) in all five case study locations, from 56% in Ranui to 72% in Papakura. The two comparison locations, Ellerslie and Kingsland, had a lower proportion of households - 38% and 27% respectively (Statistics NZ, 2013).

We also considered potential vulnerability associated with ethnicity and relative poverty. Ethnicity is relevant because of evidence that Māori and Pacific people face additional challenges in the New Zealand housing market. The housing issues that many Māori in Auckland face include higher than average rates of household crowding, lower than average home ownership rates and reduced locational stability as a result of higher than average rates of renting (Lysnar, Tuatagaloa, & Joynt, 2016). Pacific families have

the lowest home ownership rate of any ethnicity, and those in rental accommodation are subject to higher rates of 'rental churn', whereby they frequently move house (Fu, 2015).

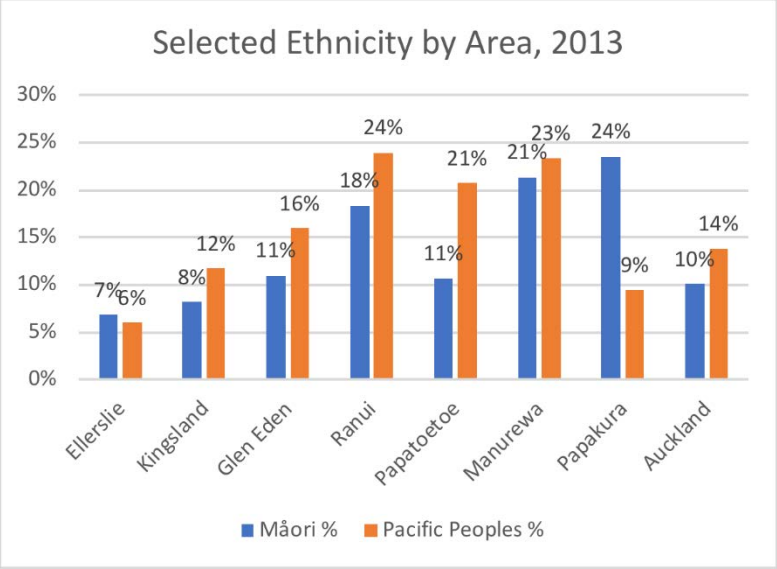

Figure 2. Selected ethnicity by area, 2013.

Another indicator of potential household vulnerability is the New Zealand Deprivation Index. This uses aggregate census information about the residents of each mesh block (the smallest geographical unit of analysis in the census) to assign a decile-rank index from one (least deprived) to ten (most deprived). The index is based on a number of variables, including the proportion of adults who received a means-tested benefit, are unemployed, and experience household crowding (Atkinson et al, 2014). All five case study locations rank between eight and ten, and are within the most deprived 20% of locations in New Zealand, in contrast to the two comparison locations – Ellerslie and Kingsland (Figure 3).

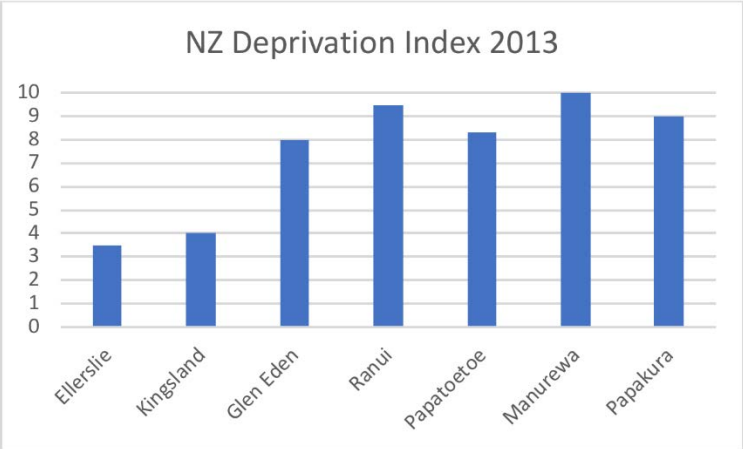

Figure 3. NZ Deprivation Index, 2013.

INVESTMENT AND REDEVELOPMENT POTENTIAL

A second aspect of vulnerability to gentrification is the potential for the case study locations to be attractive to investment and redevelopment. We have explored two aspects of this. The first is the valuation of properties in each of the case study locations, and the second is zoning changes that allow for redevelopment under the AUP. Valuations data was obtained from the Auckland Council, for individual properties which gives a broad indication of the relative value of properties across the Auckland region. Capital value is defined as the most likely selling price at the date of valuation, and land value is the most likely selling price of the bare land at the date of valuation (Auckland Council, 2017). Figure 4 shows the median land and capital value for all residential properties in 2017, along with the values for the Auckland region. The five case study locations all had median values below the Auckland region median in comparison with the higher values in Ellerslie and Kingsland.

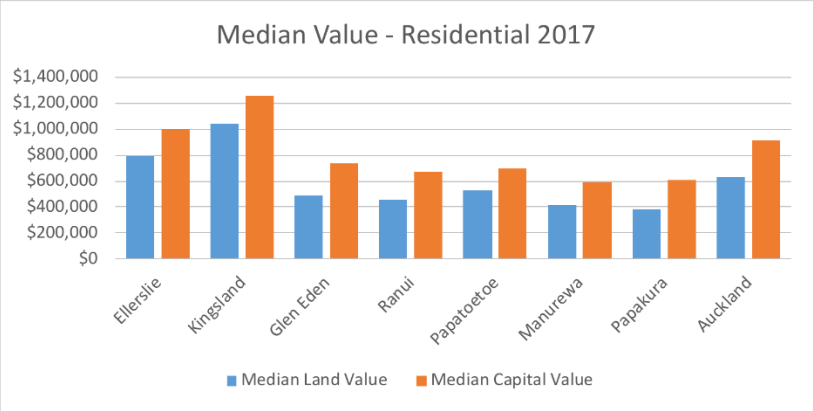

Figure 4. Median Value, Residential.

A further aspect of the attractiveness of locations for redevelopment is the zoning regulations. The principal statutory planning document for Auckland is the AUP, which became operative in part in November 2016 (Auckland Council, 2016a). The AUP introduced several new higher density residential zones and business zones which permit high intensity residential along with a range of commercial and other uses (Auckland Council, 2016a). These new zones are focused around the public transport network and therefore includes significant areas of land in all five case study locations.

However, the high prevalence of cross lease tenure in Auckland may reduce redevelopment potential. Around 31% of all titles in Auckland are cross lease or unit title properties, with over 80% of these located in areas zoned for higher-density residential in the AUP (Fredrickson, 2017). The ability of many of these sites to be redeveloped is severely restricted because cross lease properties require all the owners of a property to unanimously agree to development or redevelopment. As a result, the public sector may be more significant in our five case study locations. Housing New Zealand owns considerable areas of land in these locations and is currently focusing on redevelopment, intensification and mixed tenure development, including housing for private purchase.

MITIGATING GENTRIFICATION AND DISPLACEMENT IN NEW ZEALAND

Policy tools proposed or in use in North America to mitigate gentrification, when public transport infrastructure investment takes place, focus on value capture mechanisms and the provision of affordable housing. Value capture mechanisms have been under consideration in New Zealand for a number of years. A report commissioned by the

Ministry for the Environment (SGS Economics & Planning, 2007) recommended three options for value capture: firstly, an explicit betterment tax; secondly, negotiated agreements between a development proponent and an approval authority to deliver a range of community benefits based on 'fair sharing' of the planning gain; and thirdly, government acquisition of land prior to development rights confirmation. New Zealand legislation enabling affordable housing contributions from development passed into law in mid-2008 but was short lived. The connection between value uplift from transport investment and the provision of affordable housing was not made at that time. Since the election of a National-led government in late 2008, several reports have noted value capture as a funding mechanism for infrastructure provision, but not as a way of mitigating social impacts (e.g. Kemp, Mollard, & Wallis, 2013). More recently, the New Zealand Productivity Commission noted value capture as a potential source of infrastructure funding for local councils (NZPC, 2017).

At local government level, early drafts of the AUP considered both value capture and inclusionary zoning as mechanisms for delivering affordable housing (2013). However, neither of these tools were included in the finalised AUP (Auckland Council, 2016). Auckland Transport's policy documents on the CRL have no mention of the potential negative social impacts of the transport infrastructure once completed, and consequently no acknowledgement of the possible need to consider or address mitigation of social impacts using value uplift or any other mechanism.

CONCLUSION

Our research has confirmed that the locations around the stations along the Western and Southern Lines are vulnerable to gentrification. Public investment in the CRL has increased the vulnerability of these locations, and at the same time the AUP has greatly increased the development potential with very significant up zoning. Auckland does not have any of the policy mechanisms identified by other jurisdictions as possible tools to mitigate social impacts, indeed in so far as value capture has been considered in New Zealand it has been for the primary purposes of funding infrastructure. Clearly there is a policy gap, which if not addressed will result in significant impacts on communities.

REFERENCES

Atkinson, J., Salmond, C. and Crampton, P. (2014). *NZDep2013 Index of Deprivation user's manual.* Wellington: University of Otago.

Auckland Council. (2013). *Addendum to the Draft Auckland Unitary Plan.* Auckland: Auckland Council.

Auckland Council. (2016a). *Auckland Unitary Plan Operative in Part.* Auckland: Auckland Council.

Auckland Council. (2016b). *Proposed Auckland Unitary Plan.* Auckland: Auckland Council.

Baker, D. M. and Lee, B. (2017). How does light rail transit (LRT) impact gentrification? *Journal of Planning Education and Research.* Published online: June 21, 2017.

Cao, X. and Porter-Nelson, D. (2016). Real estate development in anticipation of the Green Line light rail transit in St. Paul. *Transport Policy, 51*(Supplement C), 24-32.

Chancellor, W., Abbott, M. and Carson, C. (2016). A study of the factors influencing residential house prices in Auckland and New Zealand. *New Zealand Journal of Applied Business Research, 14*(1), 55-70.

Chapple, K. (2009). *Mapping susceptibility to gentrification: The early warning toolkit.* California: University of California Center for Community Innovation.

City Rail Link Ltd. (2017). City Rail Link. https://www.cityraillink.co.nz/crl-travel-times/

Community Development Project. (2012). Getting there together: Tools to advocate for inclusive development near transit. *Journal of Affordable Housing & Community Development Law, 21*(1), 101.

Dawkins, C. and Moeckel, R. (2016). Transit-induced gentrification: Who will stay, and who will go? *Housing Policy Debate,* 1-18.

Eaqub, S. and Eaqub, S. (2015). *Generation rent: Rethinking New Zealand's priorities.* Wellington: Bridget Williams Books.

Feinstein, B. D. and Allen, A. (2011). Community benefits agreements with transit agencies. *Transportation Law Journal, 38*(2), 85.

Fredrickson, C. (2017). *Arrested (re)development? A study of cross lease and unit titles in Auckland*. Auckland: Auckland Council Technical Report.

Fu, M. (2015). *Children and housing: A literature review*. Auckland: Transforming Cities, University of Auckland.

Hickey, R. (2013). *The role of community land trusts in fostering equitable, transit-oriented development:* Washington, DC: Lincoln Institute.

Howden-Chapman, P. (2015). *Home truths: Confronting New Zealand's housing crisis.* Wellington: Bridget Williams Books.

Institute for Housing Studies. (2016). *Measuring the impact of the 606: understanding how a large public investment impacted the surrounding housing market.* Chicago: De Paul University.

Kahn, M. E. (2007). Gentrification trends in new Transit-Oriented communities. *Real Estate Economics, 35*(2), 155-182.

LeRoy, S. F. and Sonstelie, J. (1983). Paradise lost and regained. *Journal of Urban Economics*. 13(1), 67-89.

Lin, J. (2002). Gentrification and transit in Northwest Chicago. *Transportation Quarterly, 56*(4), 175.

Lin, J. and Chung, J. (2017). Metro-induced gentrification: A 17-year experience in Taipei. *Cities, 67*, 53-62.

Lysnar, P., Tuatagaloa, P. and Joynt, J. L. R. (2016). *Māori and housing in Tāmaki Makaurau*. Auckland: Auckland Council.

Murray, C. K. (2017). Light rail, land values and taxes. *Economic Record, 93*(302), 448-464.

Peterson, G. E. (2008). *Unlocking land values to finance urban infrastructure.* Washington, DC: World Bank.

Pollack, S., Bluestone, B., & Billingham, C. (2010). Maintaining diversity in America's transit-rich neighborhoods. *New England Community Developments,* (1), 1-6.

Residential Tenancies Act, (1986).

Revington, N. (2015). Gentrification, transit, and land use: Moving beyond neoclassical theory. *Geography Compass, 9*(3), 152-163.

SGS Economics & Planning. (2007). *Value capture mechanisms: International models and the relevance to New Zealand*. New Zealand Ministry for the Environment.

The New Zealand Productivity Commission. (2017). *Better urban planning - final report.* Wellington: The New Zealand Productivity Commission.

UCLA. (2017). Mapping neighborhood change in Los Angeles County. Retrieved from http://www.urbandisplacement.org/map/la

Viguié, V. and Hallegatte, S. (2014). *Urban infrastructure investment and rent-capture potentials*. Washington, DC: World Bank.