

A CASE STUDY ANALYSIS OF SUSTAINABLE AND AFFORDABLE HOUSING

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ABSTRACT

Housing affordability has become one of the dominant research topics in recent years. However, few studies have been undertaken to test the compatibility between affordable housing and sustainable housing. A fundamental understanding of these two issues is necessary to develop successful examples of this form of accommodation. This paper aims to identify a suite of built forms for housing that are both affordable and environmentally sustainable. A series of case studies were conducted to investigate both international and national best practice. The result was the development of a framework that enables the assessment of the overall performance of various types of housing developments.

Keywords: housing affordability, environmental sustainability, best practice.

INTRODUCTION

Housing affordability is a critical issue all around the world and a particular challenge in Australia. A recent international study comparing housing affordability in the developed world ranked no Australian urban area as 'affordable' and 25 of Australia's 28 urban areas as 'severely unaffordable' (Cox and Pavletich 2008 in AMP.NATSEM 2008). Housing affordability is currently at an all time low with more than one million low and middle income households, in a variety of housing tenures, now experiencing housing stress (Australian Government, 2008) in both the purchasing and rental markets (Beer et al, 2007; Disney, 2007; [Yates et al, 2008](#)).

Environmental sustainability of housing developments has drawn much attention in recent years, as one response to the global goal of attaining sustainable development. Sustainable housing discourse and practice is largely focused on the physical application of well-grounded principles in the design of homes and the methods and materials used in construction (Randolph et al, 2008).

Coincidentally, contemporary housing policy debate in Australia has emphasised the social and economic sustainability implications of a growing housing affordability challenge, without addressing environmental objectives. At a very practical level, these two factors have resulted in a reluctance to consider housing sustainability in the same context as housing affordability, even though both are high-priority housing challenges ([Arman et al, 2009a](#)). This background has highlighted the need to develop a comprehensive assessment framework which recognizes the importance of all components of affordability and sustainability.

This paper reports on a study carried out within the Ecocents Living project which was supported by the Department of Families & Communities and Hindmarsh to investigate affordable and sustainable housing. The project was instigated by Hindmarsh which is a property and construction company normally associated with non-residential development. As such, the project represents an enlightened initiative by Hindmarsh to work with a building education provider to determine future construction requirement; a theme which is broadly consistent with this conference's aims. The work has led to a series of publications (Arman et al,

2009a; Arman et al, 2009b; Zillante et al, 2009; [Zillante et al, 2010](#); [Pullen et al, 2010](#)) that canvass three aspects which:

- 1) provide a theoretical foundation to the research including the conceptual tensions between affordability, sustainability and core definitional issues;
- 2) develop a conceptual assessment framework to link indicators of affordability with those of economic, social and environmental sustainability;
- 3) test this assessment framework using industry input.

After a brief summary of these three aspects, this paper is primarily aimed at reporting on the follow-up research of the testing of this framework with nine housing developments.

BACKGROUND TO THE DEVELOPMENT OF AN ASSESSMENT INDICATOR FRAMEWORK

The process of developing an assessment framework covered three stages:

- Analysis of existing literature and assessment frameworks for affordable and sustainable housing
- Development of an interim affordability and sustainability assessment framework
- Validation of this framework in an industry discussion forum.

Firstly, background literature and assessment frameworks were considered. International studies into affordability in housing have been critically reviewed by Berry et al (2004) and Gurrán et al (2008). Sustainability in housing has been studied by Chui (2004), Priemus (2005), Sparks (2007) and Winston and Eastaway (2008) in Hong Kong, The Netherlands, USA, and the European Union, respectively. The literature review indicated that past research has predominantly looked separately at the two aspects of affordability and sustainability.

The following assessment frameworks with some relevance to affordable and sustainable housing were also reviewed.

- *Reducing the Environmental Impact of Housing* prepared for the UK Royal Commission for Environmental Pollution (Palmer et al, 2006)
- *EnviroDevelopment* ranking system produced by the Urban Development Institute of Australia (UDIA, 2009)
- A comprehensive sustainable housing framework with 37 equally weighted indicators developed by Blair et al. (2004)
- A sustainable community rating system developed by VicUrban, the Victorian government's urban development agency (VicUrban, 2010)

Secondly, an interim assessment framework was developed to reflect the literature findings. Affordable and sustainable housing has been defined as: "Housing that meets the needs and demands of the present generation without compromising the ability of future generations to meet their housing needs and demands. Affordable and sustainable housing has strong and inter-related economic, social and environmental components" (Arman et al, 2009b). Hence, this type of housing is complex but there is some coalescing of requirements at the conceptual level when a triple bottom line approach is taken. [Arman et al. \(2009a\)](#) argued that a number of pragmatic challenges exist to reconcile the tensions between affordability and sustainability. However, at the level of design, construction and operation of a house, there is at least some common ground where low energy materials, energy and water efficiency can be contributory factors to greater affordability.

Therefore, based on the derived definition, the conceptual findings from the literature reviews and particular aspects of related assessment frameworks, a list of key characteristics or indicators was formulated which closely reflected the important environmental, economic and social aspects of affordable and sustainable housing. These indicators form the basis of the assessment framework and they are as follows.

1. Efficiency in the use of resources e.g. energy and water.
2. Construction, e.g. materials and methods
3. Financial procurement, e.g. government, private and public private partnership
4. Affordability, e.g. purchase and rent

5. Dwelling size, e.g. mixed sizes and subjective size assessment
6. Appropriate density, e.g. low, medium and high
7. Adaptability, e.g. adopting Universal Design Principles
8. Social acceptability, e.g. acceptability to surrounding community
9. Desirability, e.g. market value of dwelling

The definitions of these indicators are shown in Table 2 of this paper.

Thirdly, in order to test the interim assessment framework, a panel of 12 experts was invited to a discussion forum. These experts represented construction, architectural, urban and social planning companies, local governments, government agencies and consumers of affordable and sustainable housing. The experts welcomed the assessment framework and suggested incorporating aspects such as safety, quality of life, quality of place and health.

This paper applies the interim assessment framework to nine recent housing developments.

APPLICATION OF THE FRAMEWORK TO CASE STUDIES

The framework was tested in recent housing developments which demonstrate current best practice in one or more components of affordability and sustainability. South Australia has a number of housing developments that claim to have such features and these were selected for analysis. The fact that some were believed to have an emphasis on sustainability rather than affordability (or vice versa) was seen as being useful as it would test the range of the framework. In addition two interstate developments were analysed to provide a national perspective and two overseas developments to give an international dimension.

The locations and scale of these developments are shown in Table 1.

No	Name	State/ country	Location	Development Size
1	Inspire	South Australia	Noarlunga, 30km to south of Adelaide CBD	28 dwellings in Stage 1

2	Lochiel Park	South Australia	Campbelltown, 8km to north east of Adelaide CBD	100 dwellings when complete
3	Christie Walk	South Australia	Adelaide CBD	24 dwellings of various forms
4	Mawson Lakes	South Australia	12km to the north of Adelaide CBD	4,000 dwellings by 2010
5	Aldinga Arts Eco Village	South Australia	45km to the south of Adelaide CBD	Currently 55 dwellings
6	Landcom NSW designs	New South Wales, Australia	Various across NSW	Various depending on particular project
7	K2 Melbourne	Victoria, Australia	5km to the south east of Melbourne CBD	96 apartments
8	BedZED	United Kingdom	14km to south of London CBD, near Mitcham	99 dwellings
9	Oxley Park	United Kingdom	70km to north west of London	145 dwellings

Table 1. Housing developments selected for analysis and their location.

Some background details of the nine developments are as follows.

Housing SA Project – Inspire, Noarlunga, (outer suburb) South Australia

Inspire was developed by Housing SA but with most dwellings being sold to home purchasers, (Brock Harcourts, n.d)..

Selected affordable housing and sustainability criteria

All houses are designed to achieve a 6.5 star energy rating. Landscaping design is environmentally sensitive with water tolerant plantings and efficient irrigation systems (ibid). Water is collected at each dwelling and water efficient appliances have been installed. All homes have a 1000 litre rainwater tank plumbed to the toilet and drip irrigation systems for watering the front yard. The land was subdivided to provide a range of small, well oriented and affordable Torrens Title allotments with the cheapest property priced at \$249,500.

Single storey homes within the project were carefully designed to meet the Housing SA requirements for adaptability. The adaptability features of all dwellings reflect the Housing SA "Design Criteria for Adaptable Housing" (Department for Families and Communities, n.d.).

Lochiel Park at Campbelltown (middle-ring suburb), South Australia

Commenced in 2004, Lochiel Park is aimed at serving as a model for other urban developments with regard to sustainable housing and land development (LMC n.d., Lochiel Park Online n.d.).

Selected affordable housing and sustainability criteria

Completed homes have used passive design techniques to achieve energy efficiency by maximising the thermal performance of the dwellings. The aim of the development is to decrease the use of fossil fuel derived energy by increasing to 15% the energy generated via renewable techniques within ten years (LMC, n.d.).

With respect to construction materials, building designers have considered the environmental effects of construction materials and products over their whole life cycle. Other examples of sustainability include the use of reverse brick veneer to maximise thermal mass and energy efficiency (LMC, n.d.).

Construction waste is aimed at conserving resources through re-use or recycling of materials to reduce the environmental impact from manufacturing and transport.

Christie Walk, Adelaide, (inner city) South Australia

Christie Walk is an 'eco-city' development consisting of three-storey townhouses, a three storey block of six apartments, four cottages and a 'community house' (Urban Ecology 2007; Reid 2005).

Selected affordable housing and sustainability criteria

Mains electricity is drawn from the grid but photovoltaic panels set on pergolas over the apartments' roof garden generate electricity for the grid. Additionally, the dwellings have solar hot water with electrical boosting. (Urban Ecology 2007; Reid 2005).

Construction materials and finishes used throughout are non-toxic. Timbers are plantation or recycled (typically, oregon). All concrete in slabs and mass walls contained the maximum percentage of flyash allowed.

The financial procurement model adopted evolved around the project being designed for a group of clients represented by a development cooperative, Wirranendi Inc. (Urban Ecology 2007; Reid 2005). With respect to affordability, the house prices (which include a share in community areas and facilities) range from \$150,000 to over \$400,000.

Mawson Lakes (middle-ring suburb), South Australia

Mawson Lakes is a fully planned 600 hectare community which, by 2010 will have 10,000 residents in up to 4,000 homes, and facilities for 7,000 workers and 7,500 students (Delfin n.d).

Selected affordable housing and sustainability criteria

Homes have been designed for energy efficiency with Home Management Systems which have the ability to control irrigation, air-conditioning and energy usage. Base power load demand is believed to be lower than Adelaide's average per dwelling but this is offset somewhat by the high peak loads in summer and winter due to a reliance on air conditioning in most homes (Saman and Mudge 2003).

Water management includes connection to a recycled water system and mandatory solar hot water. All property titles have an encumbrance that requires each house to have a dual water supply at the time of construction. Non-potable water is delivered by a purple pipe system and permitted uses for this are for toilet flushing, garden watering and car washing.

Aldinga Arts Eco Village (outer suburb), South Australia

The Aldinga Arts Eco Village consists of 169 allotments, as well as communal neighbourhood orchards, eight stormwater collection points and an amphitheatre for outdoor events (AAEV 2008; Xu 2008).

Selected affordable housing and sustainability criteria

Another site within the development is providing affordable housing that is consistent with the village by-laws in terms of environmental sustainability features. ‘The cottages’ as it is known is being developed by Co-Built and will contain 24 detached and semi-detached homes, each containing 2-bedrooms and having a floor area of 76 m² (Co Built, 2009). These cottages, which sold off the plan for approximately \$185,000 each, contain impressive environmental features, such as in-ground rainwater tanks, solar hot water, solar PV cells and internal thermal mass (being constructed as reverse brick-veneer) (ibid).

Landcom NSW designs (various locations)

Landcom (originally named the Land Commission) was established in 1975 to offer affordable houses on Sydney's fringe.

Selected affordable housing and sustainability criteria

Landcom claim that they are the only developer in the world that measures its performance of social and environmental achievements as well as financial outcomes (Landcom, n.d.). They produce an annual sustainability report based on Triple Bottom Line reporting which includes 34 indicators. Whilst most of its projects are residential in nature, Landcom also engages in a range of industrial, commercial, retail and mixed-use developments.

K2 (inner suburb), Melbourne, Victoria

The K2 development has been described as the “most environmentally sustainable public housing development in Australia” (Victorian Government, 2009). The development contains four buildings on a 4800 sqm site.

Selected affordable housing and sustainability criteria

The orientation and positioning of the buildings themselves and each individual apartment in the buildings was carefully considered to ensure maximum amounts of natural light. The buildings are four, five and eight storeys tall. Consideration was also given to air temperature and quality, with apartments designed to allow cross-ventilation.

Because of rainwater harvesting, grey water re-use, solar water heating and photovoltaic panels, each K2 apartment is anticipated to use 55 per cent less

mains electricity, 46 per cent less gas and 53 per cent less mains water compared to a standard apartment (Victorian Government 2009).

BedZED (inner suburb), London, UK

The BedZED design concept was driven by the desire to create a net 'zero fossil energy development', one that will produce at least as much energy from renewable sources as it consumes. (Twinn 2003; Bioregional, 2007.).

Selected affordable housing and sustainability criteria

Homes have been designed for energy efficiency with a typical 3-bedroom semi-detached house built to the 2002 Building Regulations with a gross floor area of 100 m² now produces around 0.47 tonnes of carbon (tC) emissions per year on average. The use of energy meters in each home helps make energy consumption more visible to the individuals in their homes.

Waste water recycling and efficient fixtures and fittings have reduced mains water consumption. Construction materials were specially designed to store heat when warm and release heat during colder weather, therefore the BedZED eco-community is built using renewable or recycled materials.

Oxley Park, (outer suburb), Milton Keynes, UK

Oxley Woods is a greenfields development in the UK resulting from the "Designed for Manufacture" competition (DFMC), a government sponsored competition which was developed to showcase affordable and sustainable housing (DFMC 2006). One winner was the residential construction company George Wimpey who came up with 'flat pack' starter homes (DFMC, 2008).

Selected affordable housing and sustainability criteria

Homes in Oxley Park have low embodied energy materials, good solar orientation, high levels of insulation, air-tight construction, and 'EcoHats', which, being the 'next generation of chimney stacks', filter all incoming air, re-circulate hot air, maximise the intake of solar heat and provide passive solar water heating as an optional extra (George Wimpey, n.d.). Reductions in the carbon footprint are claimed to be 27% from house construction, 40% with the inclusion of the EcoHat and 50% when the EcoHat is attached to top-up energy for a hot water system.

RESULTS AND DISCUSSION

Table 2 shows the assessment of all nine housing developments according to the assessment framework.

A rating scheme (0: does not meet; 1: some way to meet; 3: meets or exceeds) is employed to measure to what degree of each individual development meets the criteria of the indicator listed in Table 2. The categorisation was developed as the result of analysis using the assessment framework with 24 sub-indicators. Equal weighting was given to economic, social and environmental indicators.

When arriving at conclusions from these summary scores, it is necessary to be aware of the following limitations.

- The assessment framework and index scores are rudimentary and have been developed making a series of assumptions
- Many of the indicators are complex and the assessment using three possible options (the ✓Δ or x) does not reflect the complexity of each of the measures
- There are strong inter-relationships between economic, social and environmental sustainability which are not recognised in the ‘silo’ approach of triple-bottom-line sustainability
- The equal weighting of economic, social and environmental components may need further consideration. Indeed, a stronger emphasis on affordable housing may result in a need for a stronger weighting for economic sustainability.

Having acknowledged the above limitations of the weightings and summary scores, it is still possible to proceed with some general conclusions. The weighted summary scores provides an indication of which of the nine developments best reflect the identified characteristics of affordable and sustainable housing, in a context that provided equal emphasis on the environmental, economic and social components of housing.

The development that stands out is K2, the medium-to-high density public housing development in inner-Melbourne. The weighted summary score for this

development suggests that the project reflects nearly three quarters of the affordability and sustainability criteria that were identified. Other developments that scored well in the assessment described in this paper include the Aldinga Arts Eco Village, BedZED and Christie Walk.

The assessment framework was found to be sufficiently comprehensive to cover the majority of affordable and sustainable features of the nine case studies. The environmental indicators were the most robust with metrics and performance benchmarks mainly available. The economic and particularly the social sustainability indicators were satisfactory for qualitative analysis but their metrics require further development.

CONCLUSIONS

This paper has adopted a case study approach to identify and evaluate similarities and differences of nine recent housing developments using a comparative analysis in the form of an assessment framework. The basis for comparison was the extent to which the affordable housing and sustainable criteria had been addressed.

In conclusion, the indicators for *environmental* sustainability are quite well developed with substantial knowledge available on measurement and benchmarking of performance. However, it is likely that the benchmarks will need to be raised with time as higher levels of performance become desirable. The measurement of *social* sustainability, on the other hand, is subject to differing interpretation and contemporary indicators will require further development. A comprehensive range of indicators and benchmarks will enable the identification of housing models which can provide affordable and sustainable outcomes across the full range of requirements.

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