



Value Case for PREFAB

How offsite construction can deliver better cost-effective housing to more New Zealanders



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EXECUTIVE SUMMARY

This Value Case for Prefab includes a background on the urgent need for appropriate housing and the wall of work that the industry faces. It defines relevant terms such as prefab / offsite, affordable, value, quality, productivity and procurement. The Value Case Analysis draws on metrics from New Zealand and abroad. The resulting implications show the interrelated nature of industry roles, which reinforces the suggestion that the first action step should be leadership by Government to host key industry voices around the table to agree on a workplan going forward.

- New Zealand needs more quality cost-effective housing.
 - 15,000 houses needed in Auckland immediately – with a doubling in Auckland housing demand by 2017
 - 15,000 houses needed in Canterbury urgently
- Construction demand is increasing by 10% per year for the next four years.
 - Past booms show that when construction demand goes up, quality goes down.
- Coordinated procurement and production can result in time and cost savings.
 - Estimates are that prefabrication can remove \$25k from a standard house construction cost, and effective material procurement can remove a further \$15k.
 - \$2.5M can be shaved off industry tendering costs by reducing tenders to two quotes maximum
- Prefabrication and offsite construction is a higher quality, faster way to produce housing.
 - For a typical one-off small/medium building project this can be expected to be a 60% reduction in construction programme time, and 9.3% saving in cost
 - Value stream mapping of residential construction processes suggests that increased prefabrication could increase industry productivity by around 2.5%
 - Weather delays currently cause delays of more than 13% of construction time – saving time is the fastest way to save money – and faster build times enable more houses to be built per year using the same labour resources
- Social savings are important to quantify also – they include safer building sites, reduced disruption to neighbourhoods, and reduced environmental waste.
 - An example is the number of people working at site can be reduced in the range 60-80%, reducing onsite workplace hazards and accidents accordingly.
- Prefab and offsite construction is most effective when applied to deliver multiple build programmes.
 - This does not mean repetitive design or standardised housing outcomes. Repetitive prefabricated elements may be modular bathrooms or prefinished wall panels.
 - Precision sub-assemblies, such as hybrid (module + panel) delivery of standard housing, can mean a saving of about 15% in total construction cost – \$32,000 for a 157m² house.
- Industry and government must work together in order to lead and deliver better housing more quickly for more New Zealanders for less cost.
 - The first action step is an industry roundtable discussion facilitated by PrefabNZ to prioritise barriers to prefab uptake.



Source: Keith Hay Homes

BACKGROUND CONTEXT

New Zealand has an urgent need to build better houses faster. This combination of requirements plays to the strength of prefabrication / offsite construction through faster assembly times, better quality and freedom from weather effects. For this reason, the scene appears to be well set for prefab construction to play a significant role in delivering more homes to higher standards in the coming years.

NZ has a housing affordability problem

In 2012, a focus on unaffordable housing was provided by the New Zealand Productivity Commission's *Housing Affordability Inquiry* report. Land prices were identified as a barrier, as were building costs, cited to be 30% higher than Australian equivalents. Consumer preference for bespoke buildings was cited as a challenge to incorporating more standardised designs and products.

Consumers don't understand lifecycle value

The 2008 Better Performing Homes for New Zealanders study by the NZ Business Council for Sustainable Development found a five-point solution for upgrading existing housing stock that focused on the benefits from increased insulation, heating and water-saving solutions. The key stakeholders to improve housing were identified as central government and industry. An important finding was that insulated homes are

healthier, which leads to increased productivity through fewer days off work, lower home energy use with smaller power bills, as well as fewer hospital stays and decreased health spending. It is important that house buyers recognise the importance of lifetime value in their houses, not simply first cost.

Costs are escalating – land, compliance, building materials

Of the house and land package, land contributes about 45% of

the cost and the actual building is about 45%. Labour contributes 18% of the total cost and the building materials are about 27% (Page 2013). Land values are rising rapidly under increasing market pressure in areas of the country such as Auckland and Christchurch. Restrictions on available labour are also causing inflationary effects in Christchurch in particular.

Similarly, compliance costs have risen over the last decade and



Source: CottageNZ, 2012

contribute on average 5% to the overall building cost – see the box to the right that illustrates the difference in compliance costs from 2001 to 2008 (NZ Business Council for Sustainable Development 2008). The overall project breakdown of costs is important because it highlights that the portion that increased use of prefabrication and offsite methods can influence represents only 47% of total development cost (Page 2013).

Rising consumer expectations

The average floor area of new build housing has increased to the point that New Zealand's new houses are the third largest in the world. Where in the 1940s average floor area was 140m², it peaked in 2013 to 208m². This is despite pressures on land, reducing household sizes, and growing concerns about affordability (Buckett 2014). House sizes are influenced by the value of neighbouring properties and in some cases by covenants that demand a minimum floor

Since Leaky Homes broke in 2001

A client from walk in to start took **4 weeks**
now 4 months

A one level set of plans was **8 pages** of A3
now 17 pages

Supervision cost was **\$800** per home
now \$2800

Plans **\$600** **now \$3400**

Inspections were **6** total at **1** day's notice each
now 15 inspections at **5** working day's notice each

These are only samples of the now everyday situations!

Source: New Zealand Business Council for Sustainable Development, 2008

area or a minimum build value in order to offer a form of economic 'protection' to other neighbouring house values.

New Zealanders continue to aspire to living in standalone houses, yet shrinking household sizes point to increased demand for multi-unit properties. The majority of homes built are detached houses, with attached dwellings making up around 17% of all new builds in 2011 (Page 2013). On average, detached dwellings have made up over three quarters of the housing units built in any one year since 2000 (Buckett 2014).

New Zealand's design and construction industry faces a wall of work

New Zealand is on the brink of the biggest construction boom in 40 years, according to the 2013 National Construction Pipeline report. It points to an unprecedented level of building and construction in New Zealand over the next five years, at least 10% per annum growth for four years, peaking in 2016 when nearly \$32 billion of construction activity is predicted.

The report forecasts an increase in construction right across

the country in both residential and non-residential sectors. Construction hot spots are Auckland, followed by Canterbury and then Waikato/ Bay of Plenty and Wellington. The main drivers of growth are Auckland's residential housing demand more than doubling (projected 150% increase) and the Canterbury rebuild (Productivity Partnership, 2013).

- 15,000 houses needed for Auckland's immediate housing shortage
- 9,200 new houses will then be needed each year by Auckland, a 53% increase on the current building rate
- 15,000 new built houses needed to replace damaged housing in Christchurch

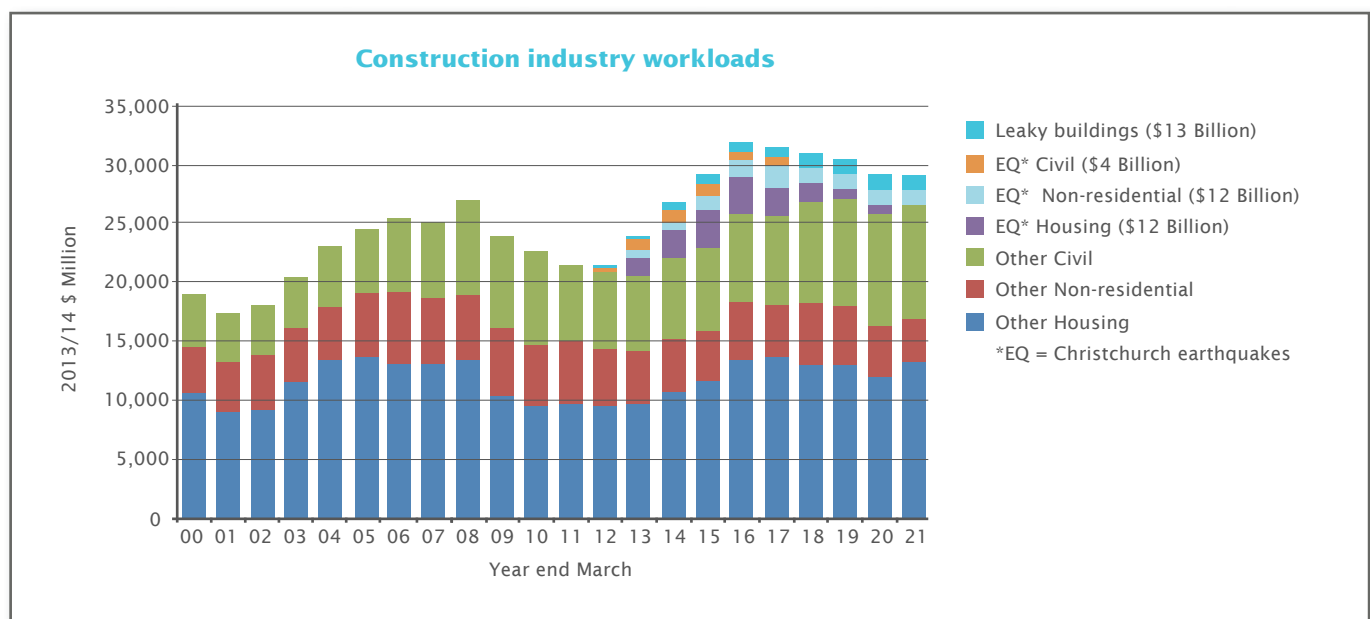
- a large number of weathertight remedial projects spanning residential, education and commercial buildings

As discussed, construction demand is increasing by 10% per year for the next four years. Previous booms in the mid-1980s and late-1990s produced evidence that workload increases of more than 5% per year over more than two years resulted in serious building performance issues – when construction demand goes up, quality goes down.

Affordable housing supply is at a critically low level in urban centres. There is increasing awareness of the need to increase density and build on urban infill sections to reduce the impact of sprawling cities.

The Auckland Council Housing Action Plan (2012) identifies the need to create exemplar high-quality medium-density urban neighbourhoods. In many cases, these types of constrained sites cannot accommodate traditional construction that requires site offices and material storage.

There are serious doubts that the contemporary industry can meet demand with its present structure and traditional methods of construction. Research by Resilient Organisations and the 2013 Construction Sector Workforce Plan focus on the Christchurch rebuild and show that skills shortages are hampering the speed of rebuilding. More efficient means of delivering the built environment are needed.



Source: Productivity Partnership 2013, updated 2014

Prefabrication offers opportunities to employ less-skilled labour for repetitive tasks, alongside their highly-skilled colleagues who are vital to running a high-tech environment. Whether producing one-off bespoke housing or multiple repetitive housing, a factory-based environment provides ideal conditions to support quality outcomes, even with a relatively new or low-skilled workforce.

Increased prefabrication uptake leads to increases in industry productivity by 2.5% (Productivity Partnership, March 2013). The Value Stream Mapping study points to a maximum savings of \$113M per annum on a total build value of \$4.2B. These savings are made up of increased client education, reduced

tendering, reduced changes on work in progress, faster construction, reduced rental costs for clients, and reduced weather delays. Although the study was not considering solutions but rather trying to quantify the size of the opportunity, it can readily be seen that all these areas identified would benefit from the flow-on effects of increased use of prefabrication techniques.

The uptake of prefabrication is currently low

The use of prefabrication in New Zealand buildings is quite low at about 11% of building components for non-residential buildings but higher at about 37% in new housing. The main use in housing is in prefabricated timber wall and

roof frames, joinery and windows. Most builders appear uncertain about the likely benefits of further prefabrication. In part this is because it would reduce on-site work for builders and the off-setting benefits of quicker construction and better quality with prefabrication are difficult to quantify.

Despite this there are several manufacturers producing panels, modules and complete buildings off-site. With the workloads in Christchurch and Auckland forecast to increase significantly builders are considering further prefabrication associated with housing and several initiatives have been announced recently (Page and Norman 2014).



Source: Keith Hay Homes

TERMS AND DEFINITIONS

In order to understand the Value Case for prefabricated housing we need some common understanding of the terms used to explain it.

Affordable

Housing is considered affordable if shelter costs account for less than 30% of before-tax household income. The term 'affordable housing' is often used interchangeably with 'social housing'; however, social housing is just one category of affordable housing and usually refers to rental housing subsidized by the government. Affordable housing is a much broader term and includes housing provided by the private, public and not-for-profit sectors as well as all forms of housing tenure (i.e. rental, ownership and co-operative ownership). It also includes temporary as well as permanent housing. In other words, the term 'affordable housing' can refer to any part of the housing continuum from temporary emergency shelters through transitional housing, supportive housing, subsidized housing, market rental housing or market homeownership.

Value

Whether a house is cost-effective or represents good value to the customer is more than whether it is economically affordable to purchase. The lifetime costs must represent a good return to the

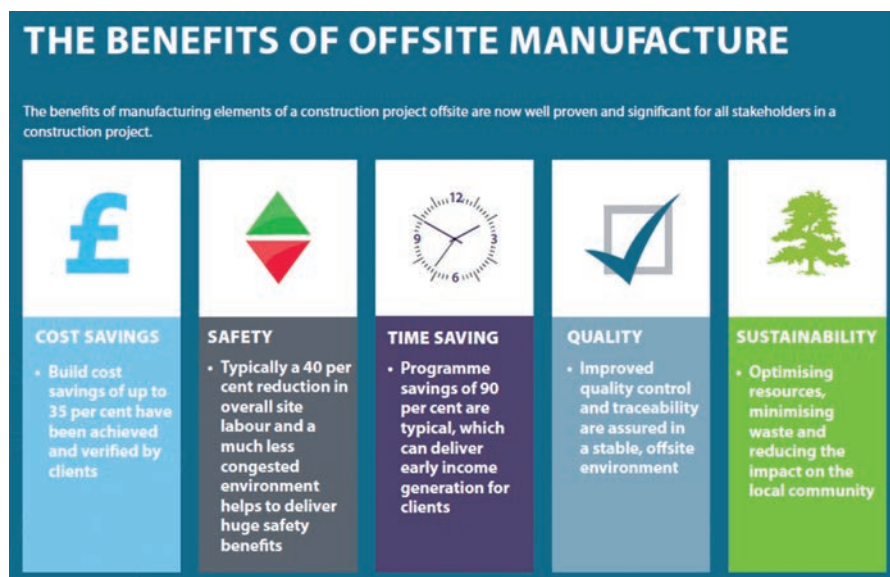
customer. The industry is currently stuck in a model where consumers demand the lowest cost up front and then pay proportionally higher running costs. A marginally higher cost up front and reduced running costs give better value over the lifetime of the house. Simple ways to deliver this type of value include passive design where the building is oriented towards the sun, increased insulation levels, and low maintenance cladding materials.

Prefabrication / Offsite construction

The New Zealand construction industry is frequently criticised for its low productivity, lack of

consistent quality, insufficient innovation, and lack of ability to address the strong construction demand existing in parts of the country. In the face of these significant challenges, sector-specific research has shown that prefab processes are one potentially very useful solution to many of these issues.

Prefab construction offers a series of practical benefits, including climate-controlled environments; reduced onsite work; reduced onsite staff; heightened quality control; enhanced waste capture and waste reduction, reuse and recycling; quality in mass and



Source: NG Bailey, 2013



Component



Panel (2D)



Module (3D)



Hybrid



Complete Building

custom design; teams rather than individuals; improved health and safety. The use of increased levels of automation in offsite construction can offer employment opportunities to less skilled workers without compromising quality. Machines do what they can do well, and humans do tasks that require skilled hands. Moves towards increased automation can improve speed, cost, quality, and minimise waste in projects (PrefabNZ Roadmap 2013).

Prefab comes in all shapes and sizes, from small components such as pre-nailed wall frames, to panels, larger modules (3D volumes) or even complete buildings. Hybrid prefab is a mixture of several prefab systems, such as modules and panels, or prefab with traditional construction. The five types of prefab are shown below: component, panel, module, hybrid and complete.

Characteristics of prefab / offsite (Buildoffsite UK, 2013):

- Predictable quality
- Predictable performance
- Low waste
- Fast construction
- Good health and safety and better working conditions
- Good sustainability
- New technical skills and multi-skills.

Prefabrication of buildings and building elements in New Zealand provides:

- Greater security in economic outcomes
- Potential for further improvement in economic outcomes, and
- Greater opportunity for enhanced environmental sustainability than traditional construction through reduced waste, transport, time, energy and greenhouse gas emissions (Burgess et al 2013).

Productivity

Productivity is commonly described as the ratio between the value of inputs (capital, labour and material) compared to the value of the outputs. New Zealand's construction industry has been criticised for low levels of productivity compared to other industries (New Zealand Productivity Commission 2012).

Multi-factor productivity (MFP) is "a measure of technological, managerial and regulatory impacts, ie. after accounting for labour and capital inputs it measures the effect of other factors that can influence performance of the economy or an industry." (Page, 2013b). The MFP of the New Zealand construction sector remained relatively stagnant between 1978 and 2010, whilst the MFP of the agricultural sector rose as innovative technology improved the output of the sector per worker.

The Building and Construction Sector Productivity Partnership is a partnership of industry and government established in November 2010 to address the issue of low productivity in the sector.

The goal is to increase productivity by 20% by 2020, which is estimated to add at least \$3 billion to the economy each year.

In Singapore, the government set up a S\$250m Construction Productivity and Capability Fund (2010).

<http://www.channelnewsasia.com/news/business/measures-to-boost/1027814.html>

Quality

It is significant that the quality of construction outputs have also been criticised, both in regards to the life expectancy and maintenance requirements of materials used, and the performance of the building (New Zealand Productivity Commission 2012). Low quality is manifest in large amounts of defects or rework.

The amount of rework needed to rectify issues is a critical area for improvement. Any piece of rework that has to be done comes off the profit of a project – rework is by definition the repeat of work already done, which would not have needed to be done again if it had been done correctly in the first place. In 2011, a survey of new house owners found that 68% had to call their builder back to fix defects present at handover (Page, 2013b). However, builders point the finger at rework areas due to changes by the client and the architect or designer (Buckett 2014).

Procurement

Procurement is the method of purchasing a building project – from design through to inception. Whole-of-life, value for money procurement is achieved through co-operation and communication with the construction industry. Recent reports in New Zealand and overseas have identified that

construction industry's short-term forecasting ability, combined with endemic 'boom bust' cycles leads to poor levels of productivity, performance and inability to retain skilled personnel. Without investment certainty, the industry cannot effectively plan for training and retaining skilled resources.

New Zealand Transport Agency (NZTA) has carried out significant work in this area by proactively engaging with industry and transparently disseminating their future work programme. This has resulted in an increased level of productivity across the civil sector as the industry is able to develop workforce plans which respond to investment signals from their clients (Productivity Partnership 2012).

Procurement practices and models, and their corresponding rules of engagement seem to be changing in Canterbury. The traditional 'cost + risk + margin' model is disappearing as transparency is now being sought leading to the market reconfiguring itself. Clients are seeking more robust, open and transparent procurement processes with opportunities for longer term working relationships with preferred suppliers that understand their business (Productivity Partnership 2011).

Shifts to more collaborative procurement models are led by more negotiated and relationship-driven approaches manifested in:

- Competitive alliance models
- Framework contracts
- Clients aware of engaging suppliers earlier in contract process
- Traditional tender route is becoming uneconomic
- Clients working on 'deepening relationships'
- Increased openness between client and supplier
- Clients need to lead the change in procurement models
- Negotiated fixed price platforms for materials – fixing prices 6 months in advance
- Need to plan and think long term

Work by the Productivity Partnership on Value Stream Mapping (2013) found that \$2.5M can be shaved off industry tendering costs by reducing tenders to two quotes maximum. This is based on the BRANZ SP 270 report that identifies one out of five newly built custom homes have five construction tenders. If these were reduced to just two tenders, then the related opportunity cost savings account for a total of \$2.5M to the industry. Refining methods of procurement and agreeing them across the industry are clearly ways to improve efficiencies and resulting productivity.



Source: Regnauer, Germany (PrefabNZ)



Source: Stanley Modular (PrefabNZ)

VALUE CASE ANALYSIS

There are three important points in framing up the value case for prefab to deliver the required affordable housing units over the next few years:

- Firstly, the greatest economic benefits of prefabrication can be gained when there are multiple units to construct.
- Secondly, prefabricated construction provides greater economic security than traditional construction in meeting budgets and timelines, given the higher level of planning and processes involved.
- Thirdly, increased building activity needs to be matched with decreased accidents and incidents at site.

In the United States, about 30% of contractors use prefabrication in most of their projects. Overall cost savings of about 6% are identified for these projects, compared to traditional construction (McGraw-Hill 2011).

A weighted evaluation of traditional versus prefabrication methods (component, panel and module) – show that when the client's decision-making emphasis is placed most heavily on cost (75% weighting), then component-based prefabrication is the best solution, and when the emphasis is shifted to quality and cost (50% cost and 25% quality) then both panel and modular prefabrication provide the

best solutions. The client's needs determine the best prefabrication delivery method in these cases. This is a BRANZ hypothetical example and it depends on the characteristics of the particular clients.

A close look at the economic case for prefab needs to take into account:

- Design (prefab and traditional design costs may differ)
- Labour (including the skills mix)
- Materials and prefab items
- Transport (including merchant to site)
- Commissioning
- Inspections

Some of the intangibles or hard-to-quantify aspects include (Page and Norman 2014):

- Health and safety
- Quality of the building
- Environment impacts such as waste and choice of materials
- Eventual demolition is easier with prefab
- Life cycle costs – traditional and prefabricated designs should have equal performance characteristics (for a fair comparison). If their on-going costs or durability differ then a life cycle cost assessment should be done
- Overheads – such as supervision

and any on-site learning costs

- Logistical – site preparation and preliminaries may differ between traditional and prefab construction

A less visible intangible aspect of factory-controlled production is that of precision sub-assemblies achieved through finely accurate tolerances. A lot of traditional construction site time is spent making parts fit together properly, mainly due to a lack of precision in fabrication. A dimensionally accurate starting point, such as a modular bathroom from which other walls can be set-out, provides more benefits than just the cost-savings of delivering a functional bathroom – potentially it can save a lot of associated construction time by reducing cumulative errors at site.

A Buildoffsite UK (June 2013) study has evaluated societal and financial benefits of prefabrication for builders and developers as the key decision makers. In situations where the construction cost savings, operational cost savings, construction time savings, and quality benefits all accrue to the same party, the case for adopting offsite methods is particularly compelling. See table at right.

Category/Attribute	Potential Improvement over Conventional Construction	Societal Benefit	Financial Benefit to Builder/Developer	Commentary
SOCIAL				
Health & Safety	Up to 80%	Large	N/A	H&S is a critical operational factor for the builder/developer, but it is not appropriate to record a financial benefit under this heading
Improved Working Conditions	Significant	Significant	N/A	Improved working conditions in the factory have little effect on the builder/developer
ENVIRONMENTAL				
Reduced Road Traffic Movements	Up to 60% (20%)	Significant	Small (Less than 1% of construction value)	Improvements shown in parenthesis are net figures making allowance for factory-based traffic movements
Reduced Energy Used on Site	Up to 80% (30%)	Small	Small (Less than 1% of construction value)	Improvements shown in parenthesis are net figures making allowance for factory-based energy consumption
Reduced Waste	Up to 90% (50%)	Significant	Significant (Up to 2.5% of construction value)	Improvements shown in parenthesis are net figures making allowance for factory-based wastage
Reduced Energy-in-Use	Up to 25%	Significant	Small	Financial savings from reduced energy-in-use are not a motivator to the builder/developer (except where the builder/developer is also the operator/occupier of the building)
ECONOMIC				
Faster Construction	Up to 60% reduction in onsite construction programme	Significant	Large (Up to 8% of the construction value)	Benefit realised through reduced project financing costs
Improved Cash-Flow	Significant	Small	Large	
Reduced Snagging & Defects	Up to 80%	Small	Significant (Up to 2% of construction value)	

Source: King and Milne, Buildoffsite UK, June 2013

Health and Safety

The number of people working on site can be reduced in the range 60%-80%. This could be expected to produce a pro-rata reduction in the occurrences of major injury and death. Subsequently, there would be cost savings to the builder or contractor with reduced accidents.

Improved Working Conditions

Job security, all weather working and organisational learning all improve worker conditions in an offsite facility. Benefits can be quantified through retained workers, reduced churn and therefore reduction in costs to retrain new staff.

Reduced Traffic Movements

A large number of small vehicles produce more exhaust emissions than a small number of large vehicles. Net CO2 emission savings have been estimated at 20% in a Virginia University 2011 study. Any attempt to correlate this with a direct cost advantage is extremely difficult.

Reduced Energy Used on Site

Energy use at site is associated with transport, staff accommodation and services,

lighting and equipment / plant. Gross savings of 80% and net savings of 30% energy are suggested by UK studies. These benefits can be quantified directly in terms of costs to the contractor.

Reduced Waste

In New Zealand, the construction industry contributes 40% of landfill. Traditional construction produces on average 10% material wastage, which may equate to 3-5% of the construction cost which is significant. Manufacturing processes are typically 1-3% by comparison. Direct savings are

suggested to be in the order of 2.5% of the traditional tender price.

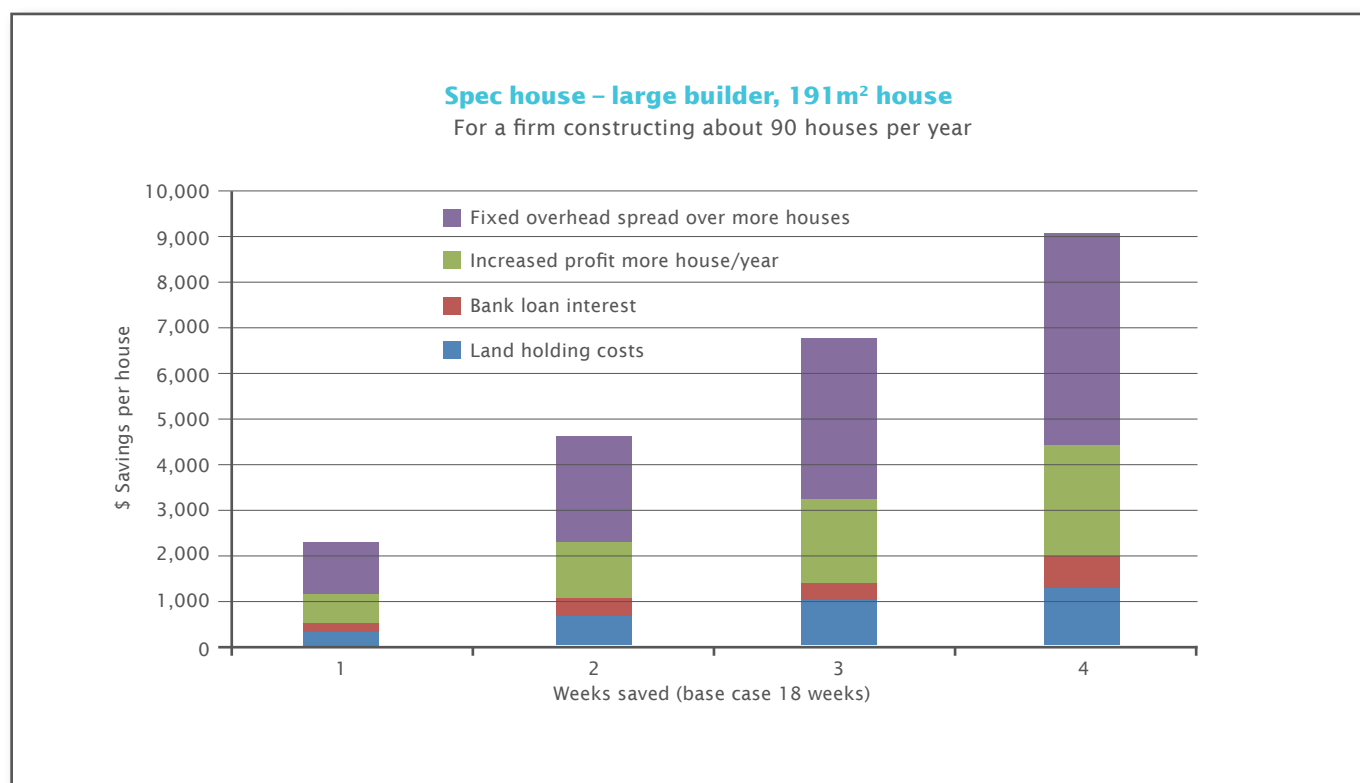
Reduced Energy-in-use

Offsite construction techniques have the potential to reduce energy-in-use because the finished quality of the buildings is generally to a higher standard. Examples include structural quality (leading to improved air-tightness) and operational efficiency (better standards of insulation). The savings are to the end-consumer, so are less likely to drive the adoption of offsite

techniques by either the building developer or contractor unless they have a continuing role as landlord.

Faster Construction

Offsite construction has many advantages, but the clearest and most frequently cited advantage is speed of construction. Dramatic improvements over conventional techniques are commonly acknowledged, with the time required to construct and commission an offsite building being typically reduced by 50-75%. Speed of construction confers a



Source: Page, 2012

major financial advantage on the building developer in the form of reduced financing costs. For a typical small/medium building project this can be expected to be 60% reduction in construction programme time, and 9.3% saving in cost.

BRANZ's Page (2012) estimated the value of time savings associated with quicker construction in housing using prefabrication. The main result was a saving of about \$1,500 per week for larger builders. See graph on left.

Value Stream Mapping work by the Productivity Partnership (2013) identified that weather interruptions currently cause delays of more than 13% of construction time. It is widely agreed that in construction, saving time is the fastest way to save money, as evidenced in the BRANZ work above.

Improved Cash-flow

Cash-flow for the contractor and developer is improved using offsite construction. The sooner the building is completed and commissioned, the sooner the owner will receive a cash-flow stream from sale or rent, which is estimated at 8% of the construction cost.

Reduced Snagging and Defects

Snagging, defects or re-work are all by-products of an imperfect traditional construction process.

Defect rates are much lower for buildings that use large-scale prefabricated elements such as panels or volumetric bathrooms due largely to dimensional accuracy in the controlled factory environment. Most building contractors make an implicit provision for snagging and defects in the order of 1% of the tender price, but the real cost to the industry is probably much larger than this. If we assume that the total cost of remedying defects is nearer 2%, and that defect rates might be halved, the benefit of moving to offsite methods is estimated to lie in the order of 1% of the cost of construction.

In summary, it may be said that the ideological and commercial benefits of offsite construction are numerous. Benefits include quality, construction time, and time certainty, reduced health and safety incidences, bypassing skill shortages, and cost certainty. Depending on where the financial benefits accrue, these factors can be expected to influence the choice of building method. In cases where the construction cost, operational costs, and time-benefits all accrue to the same party the case for adopting offsite methods is particularly compelling (Buildoffsite UK June 2013).



Prefabrication used for custom one-off high-quality housing is not always cheaper in a simplistic sense, as in lowest cost upfront.

There is significant potential for prefabrication in multiple units for schools, prisons, hospitals, retirement villages, affordable housing, and even infrastructure such as bridge- and road-building.

COST MODELLING

Tam et al (2007) found that across four broad categories of buildings (general building, public housing, private housing, commercial), prefabrication was appropriate for structural steel frames, external cladding, concrete slab, bathrooms, and internal walls. Several of these elements provide a starting point for cost modelling a typical house build using an increased level of prefabrication compared with a traditional build.

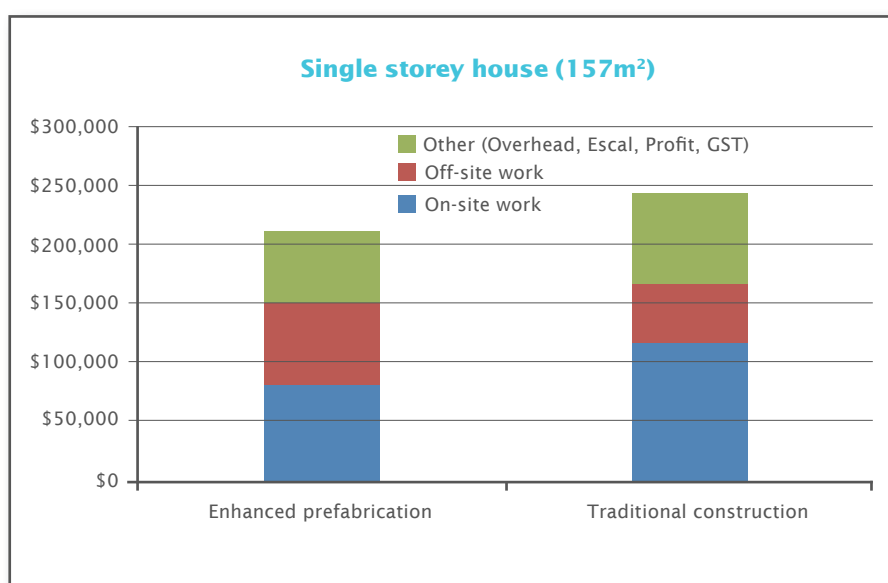
Raw data was obtained from a major house builder and modelled by Ian Page of BRANZ. The prefabrication typology used for this exercise is a hybrid (module+panel) where:

- The bathroom is fully completed off-site and is dropped in as a volumetric module. This provides the set-out and accuracy for attaching wall panels towards complete construction.
- All walls are provided as panels containing all services (electrical and plumbing), plus all linings including 50% stopping, all windows and doors. Exterior panels have plywood sheathing on the exterior.
- The roof is similarly prefabricated as flat panels including cladding.

Other assumptions are for a single-storey 157m² house with a concrete slab, on a serviced flat site. The cladding is assumed to be traditional brick veneer installed on-site. The roof cladding is sheet metal or metal tiles. A stopping top coat is assumed to be applied on-site to all linings and

all painting (excluding bathroom module) to be on-site.

As the graph shows, the traditional house construction cost was \$246,000 and the enhanced prefabricated house construction cost was \$214,000, a difference of about 15% in total construction cost. This can potentially be passed directly on to the owner.



Source: Page, 2014



This cost modelling is based on a single stand-alone 157m² house. In the future, smaller households and urban densification will mean smaller floor areas, attached dwellings, and a greater emphasis on creating communities of mixed use and medium-density housing.

Moving from traditional to hybrid prefabrication:

- Almost all traditionally built housing has some level of prefabrication. Most commonly this is the small components of wall frames, roof trusses, windows and doors, and kitchen and other cabinetry. These are significant items and amount to roughly 30% of the construction cost before overheads, profit and GST.
- Moving from component-based prefabrication to hybrid (module+panel) prefabrication means starting with a volumetric module (bathroom) and adding completed panels (internal and external, walls and roof). This brings the prefabrication content up to 47% of cost before overheads, profit and GST.
- The total cost reduction of the hybrid module+panel house is achieved through a number of areas including services (electrical and plumbing), roofing, framing and hire of scaffold and waste bin.

IMPLICATIONS AND ROLES

To materially influence the New Zealand housing market, prefabrication / offsite producers will need to innovate. Factories will have to be built and new products will have to be developed. Investment decisions will have to be taken and cultural changes will have to be brought about. To embark on a route which holds such risks will require that business leaders have great confidence that the future market is real (King and Milne 2013). This places importance on the Productivity Partnership's National Construction Pipeline reports as indicators of future workflow.

The design and construction industry supply chain currently looks to the government for strong leadership on critical issues, and to the regulators to uphold the Building Code using available technology. Future success will look different to business as usual today. At a broad level, the industry will be recognised for its significant contribution to the nation's GDP (4-8%). There will also be measures in place to grow this contribution – increasing productivity through greater uptake of prefabrication is one way to achieve this – a 10% increase in productivity equates to a 1% increase in GDP (PWC 2011). At a working level, there will be an increased flow of accessible information that clearly sells the value case for prefab.

A joint Government and Industry implementation programme is suggested to take forward

recommendations and provide examples in order to catalyse greater uptake of prefabricated housing in New Zealand. Whilst the government might create the climate for new products and provide some examples, it is the role of industry to respond with suitable market offerings. The following ten points are 'what we know' – evidence that points towards a need for increased uptake of prefabrication:

1. A standardised house plan delivered by a 'group' home or design-and-build company delivers 15% cost savings compared with a bespoke home of similar size and quality (Page 2008).
2. Developing new prefabricated building components (eg. bathroom modules) requires an up-front investment in manufacturing capability (eg. \$6M) and results in the first three prototypes being 2-3

times more expensive than the established production (Mettrick 2014).

3. Major benefits of working offsite are reduction in staff costs and efficiencies gained from a repetitive supply of work.
4. Efficiencies are gained through repetition – a visible pipeline of work, would enable a low-risk environment for the construction industry to invest in prefabrication technology and up-skill.
5. It is likely that this investment would have a flow-on effect to the rest of the industry and 'traditional' construction – the example being pre-nail roof trusses and wall frames and precast concrete panels that were developed through direct government R+D in the mid-1950s, now considered standard construction.
6. Standard house construction was recently approx. \$1,500

per sqm compared with \$1,200 several few years ago – with reasons for the increase in costs cited as Health and Safety and other regulatory compliance.

7. Estimates are that prefabrication can remove \$25,000 from a standard house construction cost, and effective ‘open-book’ material procurement can remove a further \$15,000 (Mettrick 2014).
8. For the small builder the main benefit of more prefabrication is likely to be quicker construction which allows more completions per year and hence greater profits. The client may benefit from reduced rental outgoings. The large builder also benefits from quicker construction and the ability to spread overheads over more houses per year. An increase in use of standard panels and fittings is possible for the large builder with the associated economies of scale (Page and Norman 2014).
9. All the literature, and local experience, says that early involvement of the designer, fabricator and contractor in any particular project enables the benefits of prefabrication to be fully realised (Page and Norman 2014).
10. Collaboration will be essential moving forward. A strong indicator of this direction is the recent announcement of a joint venture panel factory NZ



Source: HIVE Home Innovation Village (PrefabNZ)

Panelised by Spanbild and Mike Greer Homes in Christchurch to produce 1,000 homes per annum.

Clients

In the future, clients will experience a smooth building delivery and limited disruption at site, so will recommend the team they worked with and be willing to embark on a design and build project again.

In order to reap these benefits of prefabrication, clients need to do the following:

- Ask their architect / designer and builder / housing manufacturer for prefabrication to ensure known costs, timeframes and outcomes
- Determine / freeze their house design prior to manufacture – design changes or variations once the house is in production are likely to erode cost benefits,

and the later in the build process this is done, the more costly it will be

- Be aware of all housing options – across sizes, materials, designs and delivery options
- Touch, feel and experience showhomes in order to make an informed decision
- Know where to go for information about prefabrication – PrefabNZ www.prefabnz.com

Specifiers

In the future, specifiers such as architects, designers and engineers will collaborate with clients and producers early in the design process. They will use digital technology to share files with producers, to access online product information, and to submit Building Consent packages. Specifiers will be able to access clear and relevant information about prefabricated elements for themselves and their clients.

In order to reap these benefits of prefabrication, designers need to do the following:

- Talk to their clients about prefabrication options to ensure known costs, timeframes and outcomes, and use of standard sizes to minimise waste, avoid effects of bad weather
- Work closely with builders / manufacturers and clients from the early stages of a design and build project
- Make clients aware that the design needs to be determined / frozen early in design process
- Be aware of the full range of prefabrication options – from components to panels to volumetric modules, to hybrid and complete buildings
- Use a standard set of prefab terminology – see PrefabNZ Roadmap Directory
- Be able to drag and drop computer aided design (CAD) construction details and specification information from manufacturers' websites
- Know that the building consent process for using prefabricated methods is low-risk
- Reduce risk by being able to access built examples and showhomes that show the materials and systems in place
- Know where to go for information about prefabrication – PrefabNZ www.prefabnz.com

Producers

In the future, materials manufacturers, existing prefabricators and both large and

small-scale builders will perform more work in factory conditions and less work at site resulting in fewer defects and quicker weatherproofing, work to a shorter build time with simplified work schedules, have a lower risk of accidents with less associated costs of compliance, reduce material waste with increased profits on materials, manage fewer supplier contracts, and overall higher turnover and profits.

In order to reap these benefits of prefabrication, builders and manufacturers need to do the following:

- Talk to designers and building professionals about prefabrication options to ensure known costs, timeframes and outcomes
- Supply computer aided design (CAD) construction details and specification information on manufacturers' websites
- Be aware of the full range of prefabrication options – from components to panels to volumetric modules, to hybrid and complete buildings – their installation requirements and any associated risks, tips and tricks
- Use a standard set of prefab terminology – see PrefabNZ Roadmap Directory
- Have streamlined business processes in place to maximise administrative efficiencies to match potential building and assembly efficiencies
- Keep accurate records of intangibles, such as time saved,

materials saved, reduced call-backs, and increased health and safety – to inform their own records, price accurately for clients, and contribute to the wider industry understanding of prefabrication

- Know how to pass on prefabrication cost-savings to clients while maintaining their own profit margins
- Know where to go for information about prefabrication – PrefabNZ www.prefabnz.com

Regulators

In the future, regulators in local government and territorial authorities will use a consistent shared terminology for prefabrication terms and have a familiarity with different systems that removes fear and undue risk in the Building Consent assessment process. There will be increased use of a flexible pre-consent tool, based on standardised details and product packages, to speed up the consent process and reduce consenting costs to clients.

Regulators will facilitate on-the-job inspections by producers and monitor this through a national online consenting portal.

In order to reap these benefits of prefabrication, building officials need to do the following:

- Be aware of the full range of prefabrication options – from components to panels to volumetric modules, to hybrid and complete buildings – their installation requirements and any associated risks, tips and tricks

- Know where to reference computer aided design (CAD) construction details and specification information on manufacturers' websites
- Use a standard set of prefab terminology – see PrefabNZ Roadmap Directory
- Support self-inspection at site by producers for offsite components and onsite assembly – this doesn't take away producers' liability, and makes producers potentially liable for any faults
- Know where to go for information about prefabrication – PrefabNZ www.prefabnz.com

Government

In the future, central government will take a proactive leadership approach to continuous improvement and leading by example. A focus on collaborative 'open-book' procurement, a transparent pipeline of upcoming work, and management skills support for small to medium enterprises (SMEs) will lead to a smoothing of the boom and bust cycle. Innovation encouragement will be put in place to increase the uptake of BIM, green and prefab in multi-unit projects for schools, social housing, affordable housing, hospitals, retirement villages and corrections facilities (PrefabNZ Roadmap 2013).

In order to reap the benefits of prefabrication, Government needs to do the following:

- Work collaboratively with industry
- Lead by example, push for for increased uptake of online consenting, Building Information Management (BIM), green and prefab in Government's own multi-unit housing and commercial projects
- Support standard-setting for online consenting, BIM, green and prefab
- Use a standard set of prefab terminology – see PrefabNZ Roadmap Directory
- Know where to go for information about prefabrication – PrefabNZ www.prefabnz.com



Source: Holz 8, Germany (PrefabNZ)

ACTION STEPS

Think Global Act Local

Action must be local but reference must be made to international exemplars. There is an urgent need to act based on the current pent-up housing demand. A first step would be an industry roundtable discussion hosted by government. This would prioritise the action steps needed to increase the uptake of prefabrication and offsite construction to deliver cost-effective housing solutions for more New Zealanders.

It is interesting to note that research recommendations for industry and government from the Buildoffsite (2013) report for the British Government fall into three key areas which may be worth further investigation in New Zealand:

- INCENTIVISATION (Taking Fiscal and Taxation Measures)
- PROVIDING CONFIDENCE IN THE MARKET PLACE (Strengthening the Delivery Framework)
- SECURING THE FUTURE (Setting Policy and Making Investments)

An action-oriented approach would tackle at least four focus areas: process, procurement, benchmarking, and training.

Process

Builders can introduce prefab gradually with a mix of offsite and onsite technologies. Offsite components can be supplied by joint-venture manufacture or a single supplier for multiple

builders. In parallel to this, design-and-build firms can move toward more standardised design portfolios. This means suppliers need to be involved early on in the process of the larger projects.

Procurement

This means early involvement of client, specifiers and producers. Similarly, other stakeholders such as lenders, insurers, planning and building control authorities need more involvement.

Benchmarking

There is disagreement about which innovations matter most, and about how innovation impacts can be measured when there is no agreed criteria to assess performance beyond costs. For example, the benefits of time, quality, health and safety, and sustainability are often hidden and not fully realised by the industry. Promotion of trials, showcases and

exhibition buildings is needed to better understand these benefits.

Training

This is needed because, contrary to general belief, prefabrication will not necessarily compensate for lack of skills. An understanding of the techniques and precision involved in prefabrication is essential both offsite and onsite. There is a need to train staff on the longer-term benefits of prefabrication and to reduce staff turnover by promoting a holistic approach to innovation.

A holistic approach that tackles the challenges across all four focus areas and the full range of stakeholders considered to have a role in uptake of prefabrication is needed (Page and Norman 2014).



Source: Holz 4, Germany (PrefabNZ)

Industry dissemination and feedback

The launch of this Value Case for Prefab is at the PrefabNZ Conference in Auckland, 27 March 2014. Following the launch, immediate industry dissemination is via websites of key parties involved, including PrefabNZ, BRANZ and Productivity Partnership (MBIE). Further dissemination throughout the key associations for building professionals is through the Construction Industry Council (CIC) and major industry players through the Construction Strategy Group (CSG). Widespread industry member information is via print media, such as Build and Progressive Building magazines.

PrefabNZ provides the centralised contact point for submissions, comments and ideas related to this Value Case for Prefab.

Feedback is welcome by email to info@prefabnz.com

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