Green Roofs in the Christchurch Rebuild

Barriers and motivations influencing implementation

GEOG402 ζ Sustainable Urban Development
Kirsten Curry and Anna Larsson

Green roof technology is capable of providing extensive benefits to property owners and the wider environment. The rebuild process following the Christchurch earthquakes provides an opportunity for widespread implementation however to date none have been installed. This research investigates the international experience with green roofs, and examines the perspectives of key stakeholders in the Christchurch property and construction sector. Key barriers include cost, risk and education; while motivations are currently insufficient. Findings suggest that it is unlikely that green roofs will be incorporated into new developments without encouragement.

The earthquake events of September 2010 and February 2011 resulted in widespread and significant damage to the built and physical environment in

Table 1 provides a list of all respondents, with an indication of their knowledge of the benefits of green roofs, and any direct experience that they have had with green roofs.

Architect	Good	
Construction A	Excellent	Installed green roofs overseas
Gallery Tenant	Good	Has considered installing green roof
Landscape Architect	Excellent	Worked on green roof designs
Researcher A	Excellent	Researched green roof ecology
Researcher B	Excellent	Green roof researcher
Project Manager A (Large Corporate)	Excellent	Project has green roof element
Homeowner A	Excellent	Has green roof
Project Manager B (Large Corporate)	Moderate	
Commercial Property Developer	Weak	
Residential Property Developer	Moderate	
Construction B	Moderate	

There are a few points to note from Table 1. Firstly those who have favourable attitudes towards green roofs tend to have previous experience and excellent knowledge of the benefits. Secondly, those who are least likely to be favourable, tend to have a cost as the predominant argument against green roofs. As a generalisation, this could be considered a reflection of their professional role.

The international literature on green roofs has identified a number of benefits from these structures, both on an individual building level and a city level. For an individual building, green roofs help with energy conservation through increased insulation and the evapotranspiration of the plants. This decreases the need for heating during cold months, and cooling during hot months (Berardi et al, 2014). Green roofs also protect the roof from extreme temperature fluctuations and UV light, which can increase the longevity of the roof by up to 100% (Bianchini & Hewage, 2012). Additionally, the individual structure can benefit from increased sound insulation (Berardi et al, 2014).

On a wider scale, green roofs help cities control stormwater. The vegetation on the roof absorbs all or part of the rainfall during a storm event, decreasing the volume, staggering the outflow and increasing the quality of the water run-off. This can help prevent flooding and mitigates water pollution (Berardi et al, 2014). Green roofs provide much needed habitats for plants, insects and animals in dense urban settings, and so work in favour of biodiversity. They also help reduce air pollution through absorption of noxious chemicals and small particles (Berardi et al, 2014). Additionally, green roofs have been shown to substantially reduce the urban heat island effect, through their relatively high albedo (Bianchini & Hewage, 2012).

All of the above effects are measurable, but vary greatly depending on the climate (macro and micro), the density and form of the surrounding urban landscape, the soil depth and the vegetation type (Berardi et al, 2014). This means it can be very difficult to predict the actual outcome, both financial and environmental, of any single green roof structure. This is despite much of the contemporary green roof research being concerned with quantifying and comparing these benefits across different structures and settings. There are also benefits that are significantly harder to quantify, such

Attempts at cost benefit analysis of green roofs show a large probability that the initially greater investment of putting in a green roof will pay off, seen over the lifetime of the structure. Bianchini and Hewage (2012), using a probabilistic Monte Carlo analysis, calculate that the chance of the net present value of the investment being positive is over 98%, even before the social benefits have been included. A slightly less optimistic study conducted by Claus and Rousseau (2012), find that social benefits have to be included in the calculations for the NPV to be positive for an individual investor, and that government incentives are therefore required.

Some of the benefits outlined above are more relevant to Christchurch than others. The climate is temperate with few extreme temperature events, therefore the heat island mitigation and indoor climate control benefits are less pronounced than in other parts of the world. As Christchurch is a low-density city with a relatively high proportion of gardens and parks, the argument for more green space from a biodiversity or air quality point of view is weaker.

Stormwater management, however, is becoming an issue. This may become the primary driver for green roof implementation in Christchurch in the years to come. The location of Christchurch on the Waimakariri floodplain combined with the damage from the earthquake has made the city very vulnerable to rising water levels. Several large flooding events following heavy rainfalls in the past few months have increased awareness that action is required in the near future. Anything that can be done to reduce and delay the water runoff should be on the table.

To many of the people we interviewed, the ecological benefits of green roofs were very poorly known. Many are primarily attracted to the aesthetic aspect of it, for the wow-factor and the possibility of attaining a greener image. The Commercial Property Advisor says¢ÔTenants like the ideas and concepts of green buildings largely for corporate responsibility Ç that is, to be seen to be making a difference in the community with regard to lowering their impact on the ÅÎÖÉÒÏÎ Í ÅÎôõ. However for Project Manager B, it is a matter of creating an appealing workplace and a high quality space for the employees, as well as developing the green image of the company, although he did also mention energy costs as a potential motivator. The Gallery Tenant has a variation of this opinion, as a part of the purpose of the gallery is to suggest alternatives in the Christchurch rebuild, and green roofs fit this concept.

For Researcher A, the primary motivation for green roofs is biodiversity and creating habitats for native plants. The competition from introduced species and human activity in the landscape has greatly reduced the scope for many plants to

survive. The artificial environment of a rooftop can be used to give them a new setting, where conditions are manufactured to suit them. Many of these plants deal well with dry, nutrient-poor and unsheltered conditions and therefore work well on roofs. Biodiversity and habitat creation was also mentioned by Homeowner A as a motivation for putting in a green roof on his home, along with the energy savings and a more aesthetically based wish to make the building fit in with the surrounding landscape.

Lack of promotion from the government and social communities among the public and private sectors
Lack of incentive from the government towards the owners of the existing buildings
Increase of maintenance cost
Lack of awareness on extensive green roof system in public and private sectors
The old age of existing building
Technical difficulty during the design and construction process
Weak structural loading for applying extensive green roof system
Increase of design and construction cost
Lack of incentive from the government towards developers
The weak affordability of extensive roof to withstand wind load
Poor utilities arrangement

A report by Lockwood (2008) for Deloitte on green retrofits in general, not just green roofs, states that a green retrofit does carry a cost premium. This is often attributed to the higher cost of green engineers and designers, higher cost of materials and the time required for extra research. Despite the cost premium, , ÏÃË×ÏÏÄ ÆÏÕÎÄ ÔÈÁÔ χυÞ ÏÆ ÒÅÓÐÏÎÄÅÎÔÓ ×ÅÒÅ ÎÖÅÒÙ ÓÁÔÉÓÆÉÅÄÎ ×ÉÔÈ ÔÈÅÉÒ ÒÅÔÒÏÆÉÔÓ ÁÎÄ ψσÞ ×ÏÕÌÄ ÂÅ ÎÖÅÒÙ ÌÉËÅÌÙÎ ÔÏ É Í ÐÌÅ Í ÅÎÔ ÁÎ ÏÔÈÅÒ ÇÒÅÅÎ ÒÅÔÒÏÆÉÔ ÉÎ the future. It is predicted that this cost premium will decrease over time as suppliers become more educated and materials more readily available. There is also an expectation that over time as they become more common-place there will be a point when companies that do not have an energy efficient building will be competitively disadvantaged due to higher operating costs, lower productivity, reduced retention of skilled workers and a negative brand image (Lockwood, 2008).

From our interviews, a number of barriers have been identified, some echoing the international literature and some specific to Christchurch.

The most significant barrier is cost. This stems from the same issues as those identified internationally (higher cost of building materials, higher cost of specialised builders, more research required before construction can start), but in Christchurch it is exacerbated by the post-earthquake building situation. Construction B told us that the cost of building has gone up considerably, with the cost of materials rising and new building codes requiring stronger foundations. At the same time, tenants have also been hit hard by the quake, and can barely afford pre-earthquake rent levels. This means cost-cutting in the building phase is essential for property developers to break even.

The cost issue is exacerbated by the seven storey limit that has been set for the CBD. On a building with seven floors, the cost of the roof will be proportionally higher per square meter of rentable space than on one with twenty. However, it is evident that many buildings are not taking advantage of the roof space, which could be used as a communal staff area or the location of a cafe or bar. These

concern to his business. Builders and developers are liable for ten years after building completion, and damages

One option that has been mentioned is leading by example. Both the Architect and the Landscape architect mention

To illustrate the findings of this report, a few examples will be presented of how green roofs have been included or could be included in the Christchurch rebuild.

Tait Communications is building a new campus near the Christchurch Airport. Initial designs included large areas of green roof. However after several rounds of cost cutting this has been reduced to a small aesthetic aspect. Jurg Honger, project manager, cites issues such as short sighted accounting, and the lack of a champion for sustainability in budget considerations as causes for the loss of the green roof.

Rhys Taylor built his home in Geraldine to éÎÃÏòÐÏòÁôÅ Á ÇòÅÅÎ ÒÏ ÏÆ 4ÁÙÌÏÒïÓ motivations included the desire to create a different environment to expand the diversity of native plants that the property could successfully maintain. Other benefits such as sound insulation and energy efficiency were a bonus. Taylor had prior knowledge of green roofs and connections to individuals with experience in the field, which enabled the process. There was a higher cost in having a green roof, however Taylor is extremely satisfied with the final outcome.

Richard Batt is a property developer, creating medium density residential developments within the four avenues. A significant issue that Batt faces when creating a development is the provision of car parking. During our discussion he spoke about the potential to incorporate green roofs on garages in the future in

Berardi, U., Ghaffarian Hoseini, A. H. & Ghaffarian Hoseini, A. (2014). State-of-the-art analysis of the environmental benefits of green roofs. *Applied Energy*,115, 411z428.

Bianchini, F. & Hewage, K. (2012). Probabilistic social cost-benefit analysis for green roofs: A lifecycle approach.

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