Green Roofs in the Christchurch Rebuild

Barriers and motivations influencing implementation

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Abstract

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.

Introduction

The earthquake events of September 2010 and February 2011 resulted in widespread and significant damage to the built and physical environment in Christchurch. The extensive damage has required mass rebuilding, particularly in the Central Business District. The option of having a clean slate has excited many, with widespread support for the creation of a vibrant, sustainable green city, building on the Garden City brand. This image included green roofs, with mentions in public forums such as Share an Idea and the 2011 Draft City Plan (Christchurch City Council, 2011). A green roof is a roof with a vegetation layer installed on top. It provides a wide range of benefits to the building owners and occupants itself, and the wider city environment. The rebuild presents a unique opportunity to establish a range of green roof options.

Three years on, the rebuild is well under way, however there is a noticeable absence of green roofs. Di Lucas, a local landscape architect, brought this lack of action to our attention. This report aims to investigate why green roofs are not being installed in the Christchurch rebuild, despite the initial interest. The perceptions of key stakeholders involved in the Christchurch property market are discussed, in particular their attitudes towards the key barriers to, and motivations for implementing a green roof.

There are many cities across the world where green roof technology has been widely accepted, such as Toronto, Berlin and Stuttgart. However all the successful case studies have policy in place that provides financial benefits or makes it a compulsory requirement. This research has identified issues that are specific to the Christchurch context, and as a result has made recommendations that are feasible to support the uptake of green roofs in Christchurch.

Methodology

To answer the research question, semi-structured interviews were conducted with a range of key stakeholders who have an interest in property and building in Christchurch. These individuals were recommended by Di Lucas, suggested by individuals interviewed, and personal contacts. Respondents were explained the purpose of the project and asked about their current perception on the topic. In applicable situations, a fact sheet was presented and discussed, outlining the less known benefits that green roofs provide. The issue of green rating systems were discussed; this is the only current policy from the Christchurch City Council (CCC) that promotes green roofs. Possible policy options were discussed, in order to consider future alternatives.

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.

Table 1. List of Respondents, organised by attitudes toward green roofs

Respondent	Knowledge	Green roof experience
Favourable		
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
Uncertain		
Project Manager B (Large Corporate)	Moderate	
Commercial Property Developer	Weak	
Residential Property Developer	Moderate	
Unfavourable		
Construction B	Moderate	
Accountant Tenant	Moderate	
Engineer	Moderate	
Commercial Property Advisor	Moderate	
Homeowner B	Moderate	

Findings and Discussion

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.

Green roof benefits and motivations

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 as aesthetics and the wellbeing of people in proximity to nature.

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.

Green roof benefits and motivations in Christchurch

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: "Tenants like the ideas and concepts of green buildings largely for corporate responsibility – that is, to be seen to be making a difference in the community with regard to lowering their impact on the environment". 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.

Barriers to green roofs

Despite the many advantages of green roofs, implementation is slow in most places where it is not actively pushed by local government. This suggests there are substantial barriers to be overcome, and a relatively large international literature is dedicated to looking at those barriers in different contexts.

In their summary of the state of green roof research, Berardi et al (2014), discuss the economic barriers, namely higher construction and maintenance costs, increased complexity of building projects, and increased risk. Carter & Fowler (2008), also see the main barriers as the increased cost and risk aversion, specifically mentioning the risk of leaking. Taking a slightly wider perspective, Zhang et al. (2012), conducted a study amongst the Hong Kong construction industry, asking them to rank the importance of eleven different barriers identified from the literature. They are listed in table 2 in order of the importance they were given in the survey. This result shows that a lack of promotion, incentives and information is actually judged to be more important than the purely cost-related barriers.

There is also evidence of difficulties in adapting existing green roof technologies to new countries. A study examining the barriers to green roof implementation in Australia concludes that the lack of evidence on how the technology performs in that climate is a major barrier. Other barriers include the lack of a developed industry supplying the materials and expertise, and a need to investigate which substrates and plants will work given the specific climatic and ecological conditions (Williams et al., 2010). Developing an industry, working exemplar projects and a best practice standard can be an arduous process, and there are a lot of factors that need to be in place before any widespread adoption of the technology is likely to occur.

Table 2. Barriers to green roof implementation in order of importance (Zhang et al., 2012)

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, Lockwood found that 75% of respondents were 'very satisfied' with their retrofits and 83% would be 'very likely' to implement another green retrofit in 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).

Barriers to green roofs in Christchurch

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 facets can be incorporated with a green roof to create a pleasant and productive environment.

Related to cost is the issue of who pays and who gets the benefits. For a property developer, installing energy-saving technologies doesn't save money for them; it saves money for the tenant. From the developer's point of view, this effectively removes some of the most compelling financial motivators.

The timeframe in which developers expect to recoup their investment is generally too short to consider installing a green roof. The researchers looking at cost-benefit analyses take the whole life of the roof into account, often a period of 40 or 50 years. Over this time frame, they can include the benefits of not having to replace the roof as often and many years of lowered energy costs. For commercial developers in Christchurch, the Commercial Property Advisor estimates the timeframe at approximately ten years. As savings in the operational costs mostly accrue to the tenants, lowering the up-front costs becomes paramount. In the residential sector, the Accountant Tenant cited us a statistic that the average New Zealand homeowner will own a house for 8 years before moving on. In this timeframe, the cost of putting in a green roof will not have been repaid through energy savings.

In many interviews, 'risk' was the biggest barrier to considering a green roof system. For the Residential Property Developer, the possibility that a building would be prone to leaks as a result of the roof itself, or poor maintenance, is a

concern to his business. Builders and developers are liable for ten years after building completion, and damages as a result of a leaky roof can be large. Homeowner B spoke of the value risk that installing a green roof would have on his property as a first mover, concerned that the resale value would drop as many potential buyers would be sceptical of the new technology. The Accountant Tenant, who owned property in the CBD, spoke of risk in rebuilding there. With the population movement that has occurred and the development of business hubs around the city, there is increased risk to replacing his buildings in the central city without knowing if tenants will be available.

Lack of tenant interest in green buildings is another major barrier. The Accountant Tenant admits that he did not even ask about things such as green star ratings or energy efficiency when looking for new premises. The Property Advisor states that tenants are very rent-sensitive, and unwilling or unable to pay more for a green building. Project Manager B, comparing to the situation in Auckland, claims that in Christchurch the interest for green buildings is significantly lower. Companies in Auckland will actively request a certain environmental standard as a measure of best practice, often certified by a green star rating system, but in Christchurch the demand does not exist. At the moment, green comes a distant third after earthquake safety and affordability.

Even the people who are interested in green buildings, such as Project Manager B, put green roofs far down the list of interesting environmental building practices. They are simply not seen as providing a great deal of benefit in comparison to the cost. As the Engineer summarised, there are more effective ways to achieve environmental sustainability goals.

Something that was discovered throughout all of the interviews, even where it is not mentioned specifically, is a large lack of knowledge about green roofs. Even the people who are in the favourable group have a sometimes limited knowledge, particularly of the environmental and economic benefits. This works as a barrier in two ways. First, people who have little knowledge of the benefits will naturally be more sceptical of incurring the cost of installing a green roof. Secondly, if the proponents only frame it as an aesthetic addition to a building, rather than a part of its technological and functional system, it will be very easy to continue to write it off as an unnecessary luxury. The lack of knowledge also accentuates the perception of risk. Many of our respondents have raised issues of leakages, maintenance troubles, and concerns for earthquake safety, that the international research does not list as problems at all.

Role of council action and rating system

Although the political and legal frameworks surrounding the building industry differ from country to country, detailed zoning and building code decisions are usually made at the local city council level. In the context of green roofs, this means that the attitude and actions of the local politicians and administrators play a very important role for the degree of implementation. The local incentivising programmes have been crucial to most large scale green roof schemes to date.

Around the world, there are a large number of different schemes invented to support and encourage the adoption of green roof technology. In some places it is simply stated as a requirement in the building code, often limited to roofs over a certain size or under a certain pitch. This is known as a technology standard. Cities can also set a performance standard, where for example the requirement is that all buildings must handle a certain percentage of their stormwater on-site, and a green roof is one way to accomplish this (Carter & Fowler, 2008). A related but less strict approach is through the adoption of some type of rating system, such as the originally American but increasingly internationally adopted LEED system, or in New Zealand the green star rating system. These are normally voluntary rather than required, but encourage the inclusion of green roofs to obtain a higher rating.

In other places, primarily found in Europe, direct subsidies are given, with local governments covering part of the cost of putting in the green roof. Indirect subsidies are common in the USA, where putting in a green roof can give you for example tax credits or lowered stormwater utility fees. Another indirect subsidy is the density bonus, used for example in Portland and Chicago, where putting in a green roof allows you to increase the floor area of your building, and thus the rentable space (Carter & Fowler, 2008).

Council action in Christchurch

Some of the options outlined above simply aren't feasible in Christchurch at the moment. The city council is under enormous financial strain, making direct subsidies unlikely in the foreseeable future. Technology standards and direct requirements are also unlikely, as anything that makes the rebuild in any way harder, slower or more expensive is hard to suggest in the current political environment.

The green star rating system is in place, and gives points for green roofs. However, many of our respondents say that the rating system is too complicated and bureaucratic, and that there is no demand for green-rated buildings among tenants. So relying on that as a motivator is probably not going to result in very many green roofs being installed.

One option that has been mentioned is leading by example. Both the Architect and the Landscape architect mention that a green roof on a council building or one of the planned anchor projects would be a good way to create momentum and raise awareness.

Education and support is another method that can be employed at relatively low cost. At present, there is really nowhere a developer who might be interested in putting in a green roof can access to find out more or get advice on what actually works in Christchurch. The Auckland city council has published a set of city-specific design recommendations for green roofs (Fassman-Beck & Simcock, 2013). Something similar for Christchurch would probably be helpful.

Some of our respondents have reacted positively to the idea of a density bonus, given that land in the CBD still is very expensive and the seven storey limit reduces the amount of rentable space that can be built on any given lot. Others, like the Residential Property Developer, fear that it might cause trouble between neighbours, and the Commercial Property Advisor and the Commercial Property Developer are wary of anything that complicates or introduces more red tape and regulations to the building process.

The recent flooding events in Christchurch have also illustrated the fact that stormwater management is becoming an issue. At present, there are no citywide regulations requiring onsite stormwater retention, and no separate stormwater utility fee. Researcher B hopes that this will change, as green roofs will form part of a space-efficient solution to address these problems.

Examples

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.

Commercial Development (Tait Communications)
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.

Figure 1. Initial drawings of Tait Communications new campus

Private Home (Rhys Taylor)
Rhys Taylor built his home in Geraldine to incorporate a green roof. Taylor's 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.

Figure 2. Green Roof on Rhys Taylor's home. Photo courtesy of Rhys Taylor, Geraldine, 2008-2013

Medium Density Residential (Richard Batt)

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 order to improve the aesthetics. He did not believe that incorporating the green roofs on to the buildings themselves would provide any benefit. He cited experience with clients and their limited knowledge of the basic building efficiency features; therefore a green roof must be visible to have value.

Batt said that if he were to experiment with a green roof, it would only be if the development were on a small scale to minimise risk. He would also like to gage demand of prospective buyers before initiating the project. His latest development had potential for garages with green roofs. As an illustration of the potential for this site, Figure 3 contains a comparison of Batt's latest development as it is, and if a green roof was incorporated.

Figure 3. Richard Batt's development with and without green roofs

Conclusion

The findings of this paper can be summarised in two main points. One is that green roofs have the potential to provide great benefits for the Christchurch rebuild, in terms of stormwater management, biodiversity and energy efficiency. They would also aid in the creation of the green, friendly city that early hopes for the rebuild envisioned. The other is that unfortunately the building environment in Christchurch is not currently conducive to the implementation of green roofs. Developers are under too much pressure from costs and uncertainties already to add any elements that could increase either. Evidence from international research suggests that for the wide spread uptake of green roofs some form of incentives and regulations are required. While currently Christchurch is limited in this scope, increasing visibility and knowledge of the technology may still have some influence.

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Photoshop of Richard Batt's development – Steffan Kraberger