Green roofs: Perceptions in the Newcastle, UK CBD

Introduction

This paper explores barriers to the wider adoption of green roofs represented by the perceptions and attitudes of building owners/occupiers. It compares interview findings from cohorts with and without green roofs, to understand the potential for engendering more positive attitudes.

The paper argues that reduced awareness and understanding from businesses without green roofs means the technology is not on their radar. When asked to consider the possibility, concerns over costs and risks dominated thinking whilst potential benefits were not easily perceived, believed or felt relevant. The paper argues that if authorities wish to improve uptake, focus should be placed upon raising the profile of green roofs, helping them seem more possible and desirable, and shifting perceived norms and best practice. It concludes in asking whether this might be encouraged through more conversations around their wider values, explicitly addressing the spread of benefits and so fair allocation of costs, as well as large-scale, high-profile municipal authority projects, connected with professional and public education and training programmes, to encourage developments in approach. Professional guidance has been published by the RICS (Wilkinson et al. 2016), but awareness remains low.

A short literature review follows that also briefly outlines the paper's theoretical framing, then Methods and Findings, which continue the literature review in presenting and reflecting upon data, before discussing and concluding with significant observations and policy implications.

Literature Review

In an ever-more urbanising world (UN, 2014), the spread of impermeable surfaces increases apace as increasing numbers live in urban environments (Jha *et al*., 2011). Increases in hard-standing through urbanisation, and 'urban creep' intensification (Wright *et al*., 2011) will impact flood-risk due to reduced availability of permeable ground (Wheater and Evans, 2009), and a range of other ecosystem services (aesthetics, biodiversity, air and water quality, Gill *et al*., 2007; O'Donnell e*t al*., 2017).

It is however possible to return parts of the built environment to a more natural state. When done sensitively, in the manner of Water Sensitive Urban Design (WSUD) (Wong and Eadie, 2000), this could also offer a range of ecosystem service benefits: improvements in aesthetics, biodiversity and air quality, etc. (Ward *et al.,* 2012; O'Donnell e*t al*., 2017), which may be of interest to policy-makers (Ashley and Nowell, 2010).

The retrofitting of green roofs offers a major advantage over other forms of urban green infrastructure in not requiring more land to operate (Digman *et al.*, 2012). Unlike municipal infrastructure, though, green roofs will require the approval of individual building owners and occupiers, as well as suitable properties for installation (Lamond *et al*., 2014a).

A range of literature has been produced around the viability, effectiveness and performance of green roofs in reducing water runoff and offering further benefits (Hoang and Fenner 2014; Wilkinson *et al.* 2016, 2015 and Oberndorfer *et al*. (2007). However other published work has indicated that public awareness and understanding of green roofs remains low from the United States (Jungels *et al*., 2013) and Canada (Loder, 2014), through Spain (Fernandez-Cañero *et al*., 2013), France (Nappi-Choulet and Labussière, 2015), Australia (Tassicker *et al.*, 2016), Iran (Kalantari *et al.*, 2016) and Singapore (Yuen and Nyuk Hien, 2005), to Malaysia (Zahir *et al*., 2014) and Hong Kong (Zhang *et al*., 2012).

What has been less considered is perspectives and understandings of building owners/occupiers regarding units they control (Lamond *et al.*, 2014b; Hendricks and Calkins, 2006). This is an important matter, because it is the perceptions of those positioned to install that will allow, or block, wider adoption. Perspectives will frame practice, so it is important we understand the former, to reflect upon what might influence the latter.

Poor awareness, understanding and lack of experience appear to be major barriers to wider adoption globally (Wong *et al*., 2005; Wilkinson *et al*., 2016; Kalantari *et al*., 2016; Zahir *et al*., 2014):

> *'While green roof technology offers clear environmental advantages … many building-owner respondents either do not know about or value these advantages.'* (Hendricks and Calkins, 2006, 148)

Green roofs have been argued to offer a variety of immediate benefits to owners/occupiers, such as thermal buffering or insulation (reducing the need for heating in winter and cooling in summer), reduced maintenance costs and extended roof life (Wilkinson and Reed, 2009; Nelms *et al.*, 2007). However, it is clear that owners/occupiers and investors will not be the sole beneficiaries of many wider benefits; flood risk reduction, carbon/nitrogen sequestration and aesthetic improvements are shared across neighbourhoods and wider society (Lamond *et al*., 2014b). Although it is possible businesses may pursue societal benefits for purely altruistic motives (Olubunmi *et al.*, 2016), it is more likely that neighbourhood and societal benefits will influence decisions if owners/occupiers see potential for these to feed back into business goals.

Two suggested routes for realizing green roof indirect benefits are increased property value from uprating of a business area through increased traffic, and increased profitability through enhanced company image (Nappi-Choulet and Labussière 2015); a positive company

image generated by Corporate Social Responsibility (CSR) has been shown to increase customer loyalty or intention to use businesses (Liu *et al*., 2014; Loussaïef *et al*., 2014). The potential to attract, retain and satisfy (thereby hopefully encouraging greater productivity from) high-quality staff is another CSR motivator (Klimkiewicz and Oltra, 2017; Loder 2014). Of course, CSR can be manifest through social, economic or environmental means, and even within environmental themes there are multiple actions companies can take to improve sustainability. However, using the built form to display environmental awareness has been a theme within the green building debate (Nappi-Choulet and Labussière, 2015). Arguably, a well-publicised green roof is a highly visual badge of CSR environmental commitment that can be exploited to gain potential custom and boost turnover. Businesses situated in central districts are best placed to use their real estate to influence brand image, however different business sizes and sectors may anticipate variation in the impact of environmental CSR on their customer base.

The theoretical origins of the paper were loosely developed around the family of Rational Choice Theory (RCT) approaches (Scott 2000), which assume that perceptions of costs and benefits will steer, if not determine, behaviour. A simplistic, but 'thick' (Hechter & Kanazawa 1997, 191), understanding of RCT was the starting point, accepting that all actors would have their own values affecting decision-making, but that they would be seeking some form of 'benefit' maximisation, the details explored through interactions. Corporate Social Responsibility was incorporated as one type of perceived benefit (for the anticipated financial returns from improved image).

This worked in tandem with an understanding of the Theory of Planned Behaviour (TPB), which argues that people's attitudes, subjective norms and perceived behavioural control will shape their behaviour (Ajzen 1991); not that respondents would need any

understanding of how to install green roofs, but rather whether they had a grasp of what green roofs were, how they function and whether their building might be suitable. A number of useful papers employing TPB in a buildings and environment context have emerged recently (Wu et al. 2017, Suki and Suki 2015), which gave the authors confidence in adopting this approach.

Importantly, the authors were not looking through one particular theoretical lens in conducting this research; rather, they were treating these as useful tools at the early stages of exploration, and as the results that will be discussed demonstrate, it emerged that such lenses would only be useful at a later stage once green roofs were on the radar for consideration by non-roof-owning respondents.

Methods

To address the paper's principal question, the team undertook two stages of research, interviewing firstly those with and then those without green roofs. This involved a combination of purposeful and more convenience-oriented sampling (Marshall 1996), targeting green roof-owning businesses and then willing CBD respondents.

Semi-structured interviews were used throughout, to encourage respondents to talk freely and allow new points-of-view to emerge (Wengraf, 2001). The interviews were digitally recorded, then transcribed and coded using qualitative data analysis software (NVivo) according to themes (Hilal and Alabri 2013); coding and analysis was interpretive and entirely manual, rather than computer-aided, due to the small sample-size and the feeling that this would allow deeper engagement with the data (Welsh 2002). A grounded theory approach (Glaser and Strauss, 2009) was used in analysis to allow themes to emerge directly from the data. Due to the restricted sample size, the paper focuses upon observation of data themes rather than attempting to quantify or generalize findings.

Interview questions were developed from Lamond *et al*.'s (2014b) conceptual model of green roof benefits (fig.1). The model presents findings from a systematic literature review, scaling out from the actual and perceived potential benefits for owners/occupiers, through neighbourhoods, to wider society and whole ecosystems.

Figure 1.

Buildings with green roofs were sought in stage one through a review of online information repositories (e.g. thegreenroofcentre.co.uk and ecogreenroofs.co.uk). Interviews were arranged and conducted with owners/occupiers of ten buildings (Facilities Managers of a mix of nine for-profit and not-for-profit organisations and one self-build owner-occupier) to explore awareness, understanding and perspectives. In stage two, a social research company was employed to survey twenty-five owners/occupiers of buildings in the Newcastle CBD without green roofs to investigate the same areas.

The Newcastle CBD was selected for several reasons. Firstly, the city has a significant recent history of serious flooding, with the 'Toon Monsoon' of 2012, where roughly 5cm of rain fell in under two hours, flooding road links and causing severe traffic disruption (Pregnolato *et al*., 2017). Secondly, the authors have been involved with projects looking at Newcastle over the past four years, providing significant experience of the area, including a study that pointed to the viability of applying green roofs to a sufficient number of buildings in the CBD to help reduce flooding within the district (Lamond *et al*., 2014a). Finally, through collaborative work underpinning these projects the Local Authority has expressed interest in green roofing, improving the sense of practical feasibility (O'Donnell, *et al*., 2017).

The first stage of the research addressed twelve key questions, and allowed understanding of the relative importance of benefits to emerge, and for new themes of interest

to develop from those with direct roof experience. This then shaped the topics addressed in shorter interviews with CBD respondents, most of whom were less conversant with roof technology; again, twelve questions were asked, but elements were removed whilst other relevant issues were added.

The great majority of CBD respondents were occupiers, with several managers from larger chains and a couple of owner-occupiers. This shaped the questions asked from Lamond *et al*.'s (2014b) conceptual model. Property value was in one sense less relevant, whereas the potential for increased traffic from district improvement was more germane (and would likely result in higher rental costs). Due to the layout and location of Newcastle, Urban Heat Island (UHI) effects were not relevant. Similarly, because respondents were owners/occupiers of existing buildings, planning consent was not relevant; nor was reducing the need for drainage infrastructure, since drainage is not metered. Water quality benefits would further accrue at neighbourhood and society levels, with no requirements to monitor this for commercial use in the UK. Finally, carbon sequestration, erosion and stream degradation were not directly asked about during the shorter CBD interviews and neither did they come up in conversation, presumably not being of much concern to respondents.

Findings

This section presents findings in a manner consistent with Lamond *et al*'s (2014) conceptual model, working from the core outwards, considering the above-mentioned exclusions.

Extending roof life

The literature has suggested that green roofs can extend the life of materials, protecting them from exposure to temperature-changes and pollutants (Castleton *et al*., 2010; Nelms *et al*.,

2007). This should result in reduced cost and disruption for owners/occupiers. Most GR respondents felt confident that such roofing would extend roof-life:

> *'I think it preserves the length of life of the roof membrane … it gives a more stable environment'*

> *'it lasts much longer because it doesn't get overheated, or frosted'*

A few felt unsure about the likelihood of extending their particular roof's life, due to the building's nature or the roofing materials used. Importantly however, they did not argue against the general principle of roof-life extension:

> *'I'm not sure about extending the roof life, because it's a timber building and because there's various legal arrangements in terms of the site'*

Many CBD respondents demonstrated lack of awareness and understanding of the potential for extended roof-life, which understandably leant many towards a more risk-averse position. The greater number expressed uncertainty ('I'm sitting on the fence on that one', 'that's not a simple question'), a few said they would make no difference and a couple held that they could actually damage and so shorten roof life ('you need protection on the roofs and I wouldn't say that would be protection'). Around one fifth agreed that greening could extend roof-life (keeping it 'safe from the elements'). It could reasonably be presumed such uncertainty might tend building-owners towards traditional roofing, where benefits are not foreseen by many whilst greater risks are perceived by some.

Thermal Buffering

Greater awareness and appreciation of the thermal buffering qualities of green roofs (Fioretti *et al*., 2010) was seemingly exhibited by both groups. All respondents from the GR cohort expressed appreciation, whether or not it had been a direct consideration on installation:

> *'It adds another layer of insulation to the envelope of the building'*
>
> *'We live in a cold climate, so thermal insulation is a motivation'*

From the CBD cohort, the majority of respondents agreed in principle that green roofs should be beneficial in this regard:

> *'I think it would help in lowering bills and energy efficiency'*
>
> *'I think these things provide terrific heat retention and it's cooler in the summer as well'*

However, a sizeable minority lacked certainty ('It does sound plausible', 'I don't *think* so'), pointing again to lower awareness and possibly acquiescence, or social desirability, bias (Krumpal 2013, Kuru and Pasek 2016) whereby respondents either go along with an interviewer's apparent preferences, or provide answers they feel they 'should'.

Reduced Maintenance Costs

Considering whether green roofs might lower maintenance costs (Gordon-Walker *et al.*, 2007), GR interviewees gave a mix of responses. The large majority agreed that maintenance was low, strimming grass, removing young trees that had taken root and letting nature do the rest:

> *'The main benefit is extended life of the roof and lack of maintenance – that's zero maintenance'*

'The maintenance of it is purely cutting the grass and maintaining the drainage channels … it's quite happily doing its own thing'

A small minority, however, spoke of needing to intervene more, to preserve biodiversity and integrity roof structure integrity:

'If you leave it to its own devices … it would probably turn into a monoculture of whatever was the most rank and invasive grass species'

'[Our] suggestion would be that people consider, very carefully, the maintenance implications … and then carry through with [the] maintenance regime religiously … That's the area that's much under-estimated'

The general CBD consensus was that green roofs would cost more to maintain, due to cutting back plants and clearing waste:

'I suppose the maintenance costs would be up on the very little we pay to maintain our roof at present'

'If it has more waste and gets blocked it probably gets more expensive'

A small number of respondents felt maintenance should be covered by the Local Authority, indicating a presumption that green roofs would be adopted under local government initiative rather than a building owner's agency:

'As a business-woman I would expect it to be covered by the whole NE1 thing [a Newcastle Business Improvement District initiative] *we already pay for'*

'Surely it's going to be managed by the City Council?'

This points to the need to consider who would benefit from such roofs and who should pay, in what proportions, something that has been discussed by multiple authors (Lamond *et al*., 2014b; Tayouga and Gagné, 2016; Olubunmi *et al*., 2016). The respondent above mentions NE1, a Business Improvement District, which will be returned in the Discussion.

Stormwater attenuation

Moving on to matters concerning wider neighbourhoods, controlling stormwater flows should be a significant concern in locations such as Newcastle, which suffered badly the 2012 'Toon Monsoon'. As attested by the Commission for Architecture and the Built Environment (2011) and a large number of other authors (see Mentens *et al*., 2006 for a comprehensive literature review), green roofs hold the potential to quite significantly affect both stormwater run-off and the quality of water returning to watercourses following storm events; it has been argued up to a 54% reduction in run-off for individual buildings with an 'intensive', or deep, green roof (Mentens *et al*., 2006).

All GR respondents were aware of and appreciated the roofs' ability to attenuate stormwater flows. Half were not in areas at flood risk, so they had not been installed for this purpose, although with others this was mentioned as a concern and so benefit:

> *'In torrential rain, you get a massive amount of water coming off [the roof] and it would overflow the gutters. It doesn't anymore, because it just gets soaked in'*

> *'The green roofs were selected to help with attenuation in heavy rain – they soak up huge amounts of water and then release it slowly'*

With the CBD group, less than half felt confident that green roofs could reduce flood risk, but the confidence of those who concurred was clear and strong:

'I think it would help 100%'

'Having plants and green spaces … would help, it sounds like a good idea'

Another quarter did not feel green roofs would make any significant difference:

'It wouldn't make no difference'

'No, many things will affect flooding, that is not one of them'

Roughly the same proportion expressed a familiar uncertainty with regard to green roofs' effects on run-off, again indicating awareness and understanding issues amongst those who had not previously considered installations:

'I don't know. I'm not really well informed about how it works'

'I don't understand anything about them, if I'm totally honest about it'

This lack of understanding could stand as a major barrier to building-owners considering green roofs in areas at flood risk.

Aesthetics

Respondents with roofs that could be seen by local residents or employees were happy to be able to offer aesthetic improvements:

'Residents on the other side of the railway … they weren't looking at tin sheds, they were looking at something a little bit more attractive'

'The pitched roof … you look across the green area with trees and you see a continuation of the green area, so aesthetically, that was good'

The majority of CBD respondents sensed that they may improve the aesthetics of the city:

'It would create a better-looking city centre'

'It will make the city a lot more appealing'

Some questioned who would see them, however, and several felt that any change would be for the negative, for the public if not themselves, altering the appearance of buildings and moving away from tradition:

'As long it doesn't change the look and the tradition of the City'

'It would probably be a problem in a lot of people's minds'

This resistance to aesthetic change is understandable, since the character of Newcastle is important; parts of the centre are a conservation area, due to buildings' heritage value. However, those most suitable for green roofing are generally of more modern construction (Lamond *et al*., 2014a). The comments reflect that aesthetic tastes will differ, and that local involvement will be needed to ensure installations create aesthetic improvements for most people.

Biodiversity

The great majority of green roof owners appreciated their potential for improving biodiversity. This was a significant motivating factor in only one case, but was clearly a concern at an organizational level to mitigate the potential damage of imposing more hard-standing and grey infrastructure upon the natural environment:

'There are lots of different insects … up there as well, so it's quite diverse and vibrant up there after two years'

'If you have a sedum roof, you've got all the birdlife, you've got the insect life on there, you see butterflies around there, you get everything'

Within the CBD, a quarter either said the roofs would not help with this in a city-centre location, or expressed ignorance of the matter:

'The only wildlife you'd get around here would be feral rats in the drains ... I wouldn't say it would have any impact in the city centre'

'No, I don't think it would have any impact'

Around another quarter accepted that they could increase biodiversity, but felt this would not be a benefit, picturing biodiversity as more insects that they or other visitors would not appreciate:

'I like the countryside, but there are loads of people in the city that don't like the countryside'

'Too many insects ... I don't mind some but I don't like them ... people don't want insects or flies when they are trying to eat'

Such attitudes indicate that these groups did not associate biodiversity with the urban environment, possibly more with peri-urban and rural spaces. A small majority, however, did express appreciation for the benefits green roofs might provide:

'For me that would not be a disadvantage, I am all for increasing the bug population'

'It keeps bees, which is good for the environment'

Further multiple benefits

Whilst acoustic damping (noise attenuation) is considered a benefit of green roofs (Arthur and Wright 2005; Ding *et al*., 2013), it did not appear a significant concern to respondents. Only two GR owners mentioned it as a consideration; no CBD respondents spoke of the issue.

Similarly, air quality was not much considered by the GR cohort, although when asked, respondents agreed. Almost all CBD respondents agreed that green roofs might improve air quality, although responses again indicated possible acquiescence or social desirability bias:

'I imagine it would have a positive effect'

'I think it will, be more green'

This supposition was somewhat strengthened by other CBD respondents indicating awareness and understanding issues:

'If there is no pollution, air is not polluted by the rain'

'It would make it worse – things would sink through the roof'

Unprompted, hardly any mention was made by either group of amenity. Several CBD respondents indicated they felt increasing the availability of CBD greenspace could improve the urban environment, but not did not connect this with green roof prevalence:

'I think it would have a positive effect. Everyone wants to live somewhere green'

'Everyone likes green areas in cities, it's just more positive, helps the city in general'

This preference for the amenity value of street-level green infrastructure indicates a potential crossover benefit of green roofs, were they visible to city occupants.

Image and social responsibility

Green roof respondents were generally very aware of the PR benefits potentially stemming from such roofing. This was not, however, admitted as a significant motivating factor by any, although to what extent responses were influenced by context is difficult to say:

> *'Reputation-wise, I suppose it enhances the reputation of the organisation because it's a clear demonstration of being environmentally sensitive'*

> *'Somebody sitting there who's a green person, they're more likely to come here than next door. We're not sharply commercial ... there are a number of people it appeals to'*

The implication is that installing green roofs was more a personal choice to be consistent with 'who we are' than any public-facing concern. Whilst impressive at the individual case level, it does not offer insight into how the wider adoption of such roofs might be encouraged.

Most CBD respondents were not convinced that a green roof would have significant effect upon their business' performance:

> *'It wouldn't make any difference'*

> *'I don't think it would affect my business directly'*

This is interesting, as one presumed motivator for businesses installing green roofs would be the 'greenwash' benefits of doing something so public-facing (Olubunmi *et al*.,

2016). However, a good number of respondents were working on the basis that roofs would be neither accessible nor visible to the public, negating most positive PR-feedback.

A smaller number sensed the positive potential from installing green roofs, whether for staff or potential customers, presuming the roof's visibility and/or accessibility:

'I think my staff and the people who come [would find it] much more pleasant'

'I suppose it would be a novelty and people will go and have a look'

One respondent sensed a potential competitive advantage, were they the only business with one, but that if such roofs were city-wide then this would be cancelled out:

'If it was the only building or only two buildings, it would probably be good for public relations … but if you have a city of that, it's probably not going to affect the PR as much'

The respondent was thinking of individual competitive advantage over wider potential area benefits from increased footfall and commerce. If such views were held more widely, then a general consensus would need to be developed amongst building owners/occupiers around a 'common good', such that they might all agree to contribute and alter their roofing. Pursuing a green roof programme at a municipal level backed by Local Authority funding, awareness-raising and educational efforts might, under such circumstances, be a productive way forwards.

Who should pay?

As mentioned, there was generally a strong reluctance to the idea that businesses should directly pay for green roofs. For some, this was because enough taxes were felt to already be paid, such that financing should rightly come from local/national government resources:

'It should come out of the council budget; we pay the council tax … we pay late-night levies … there should be enough money in the pot for that to pay for it'

'We pay road taxes which should be used, not an additional tax, like an air tax and a looking at leaves tax'

Several respondents accepted they might make contributions proportionate to business-size, larger firms contributing more, to the point where smaller enterprises offered time and ideas rather than money:

'I'm just a small business so I haven't really got all that much extra to spare – that's where big business could help'

'Bigger businesses should give more and poorer businesses should give time'

'Definitely not financial [contributions], I'd be prepared to input ideas'

However, shop-manager respondents of larger businesses were not convinced that their head offices would pay for green roof work, indicating that the displacement of financial responsibility could continue:

'I don't know if my business would pay for the green'

'Certainly head office would be unwilling to contribute anything'

These strong objections to taking on costs highlight that CBD respondents did not see green roofs as their concern to take action over or that they might benefit from (through increased turnover and/or reduced absenteeism and increased productivity amongst staff, for example), but rather a matter for authorities to deal with; a number of respondents were happy to have

green roofs, so long as they were not installed and maintained at their expense (including paid staff time):

> *'As long as they're going to take responsibility for maintaining it as well, and won't leave … the business-owners to pay'*

> *'Businesses have got to be streamlined; if they employ somebody who's got time available to go and tend these gardens, they're obviously not running the business very well'*

These reactions point to participants not perceiving green roofs as bringing them any significant benefits to be balanced against costs. There was instead a sense from the majority that the costs were upfront and direct, and that any benefits to them and their building/business were possibilities, rather than concrete and directly monetisable:

> Interviewer: *'Can you think of any advantages?'*

> *'No, not really'*

> *'I can't, to be totally honest'*

> Interviewer: [suggests various possible advantages]

> *'Maybe', 'I suppose so', 'Could do', 'I don't know'*

From several others, there was an acknowledgement of potential positive impacts upon the environment and so a *moral* imperative, but a failure to connect these back to tangible benefits for the individual business-owner, or to acknowledge the value of more direct benefits:

'I guess if you're thinking morally towards the environment, it's got advantages, but as a business-owner I won't see any advantage other than, would my bills go down? … From a moral point of view, you can't really deny there would be advantages.'

Such responses may have been coloured by the fact that these were small business-owners, wrapped up in the day-to-day concerns and pressures of making ends meet in an austerity-driven market. In this context, green roofs could appear a luxury concern:

'A lot of people say green ideas are fine, but they cost, they cost, and people are in struggling times, in hard times – I don't agree that it's cost-effective'

Discussion

If authorities wish to increase green-roof uptake, then as Wilkinson *et al*. (2016) note, this could be done either voluntarily or mandatorily; a mandatory approach is presumed impractical for the UK given the socio-political setting, and so it is presumed this will need to be voluntary. The next question is how to encourage the development of a culture and understanding whereby voluntary adoption might begin to happen within the urban setting.

It is evident from this study that green roofs were simply not on the radar of building owners/occupiers in the CBD sample studied. This made the loose theoretical framings of RCT and TPB mentioned at the beginning of the paper somewhat less relevant; without prompting, respondents would not be considering the *actual* costs and benefits of something they were not aware of or had no interest in, due to lack of understanding.

When green roofs were suggested, *perceived* building-level costs and risks were more apparent to CBD respondents than actual potential benefits. Wider benefits were less recognised and felt less directly relevant (not accruing to the building-owner/occupier),

demonstrating that they were not recognised for their CSR potential, or CSR was not a significant consideration. In any case, unprompted, green roofs were not a consideration from a Rational Choice Theory perspective, and when suggested perception was skewed by misunderstandings; costs were felt to outweigh benefits, conversation closed. From a Theory of Planned Behaviour perspective, respondents' attitudes and subjective norms would be prejudiced against such roofing and their perceived behavioural control would further be low due to the same lack of understanding.

Lamond *et al*., (2014b) note that a robust Cost-Benefit Analysis around green roofs is still some way off. Contrasting papers have asserted that green roofs would pay back over the short-term (Bianchini and Hewage 2012), and that costs would never be outweighed by benefits, subsidies being required to motivate installations (Claus & Rousseau 2012). Arguing for a quick pay-back might therefore rightly be contentious.

The "business case" for direct benefits (extended roof-life, improve thermal buffering, reduced maintenance costs) and improved corporate image were acknowledged by the GR sample, but not admitted as driving influences behind installations:

> *'We had to do a certain amount of it as a leap of faith … we feel that it's the right thing to do, we've got the opportunity to do it, let's do it'*

> *'We did the green roof because … we were wanting to be as environmentally good as we could'*

It being 'the right thing to do' and wanting to be 'environmentally good' indicates that benefits beyond the building were more important than building-level costs and benefits.

That the cost-benefit balance is still somewhat a matter for debate, and those who installed green roofs were not primarily motivated by such considerations, points to

discussions around building-level gains and losses not being where the conversation needs to be, for the moment. The issue is perhaps more one of looking to encourage shifts in wider societal discourse, perceptions of green roofs and environmental responsibilities, to affect attitudes in the first instance (promoting a greater sense of 'environmental citizenship, cf. Dobson 2007) more than seeking to effect changes in behaviour with arguments around monetary gain. At a later stage, thinking through the distribution of costs and benefits and realigning payment responsibilities to match would of course be imperative, but the first step must simply be getting green roofing on the table.

Several Newcastle CBD respondents were aware of this, observing that the profile of green roofs needed raising to generate interest and awareness and arguing that the Local Authority should set an example by establishing green roofs on its buildings:

> *'I don't think there's a high-enough profile; it needs to go up to Council* [Local Authority]*, to be advertised on TV, it'd raise awareness'*

> *'If the Council did a building with a green roof, that would sort of generate people's interest'*

This returns us to the respondent in *Image and Social Responsibility* who focussed upon individual competitive advantage over any wider gains from area uplift, and the business-woman in *Reduced Maintenance Costs* who responded that she would expect green roofs to be paid for by the Business Improvement District (BID) NE1:

> *'If it was the only building or only two buildings, it would probably be good for public relations … but if you have a city of that, it's probably not going to affect the PR as much'*

'As a business-woman I would expect it to be covered by the whole NE1 thing we already pay for'

Businesses within a BID will usually pay a percentage of their rateable value above business rates towards projects intended to benefit local commerce. Wolf (2006) has written about the Washington, DC's BID work removing graffiti, street-landscaping and improving physical amenities, whilst Sheffield's BID invested in flood-risk reduction (Environment Agency, 2014) and NE1 pays for street-cleaning and capital investment (NE1 2017). BIDs therefore already conduct works to provide commercial uplift, with commercial owners/occupiers paying towards these. As just one example of a possible direction of change, then, it might be possible for Local Authorities and BIDs to work together to raise awareness and demonstrate the feasibility of green roofs, if convinced of their potential for economic and societal returns. Large-scale, high-profile projects with industry promotion could then help raise building owners'/occupiers' awareness (Tassicker, 2016b; Nappi-Choulet and Labussière, 2015), whilst projects linked with education, awareness-raising and 'environmental literacy' conversations (Hoffman and Henn, 2008) as well as potential health impacts (Wilkinson and Orr 2017) could begin to shift perceptions around their value.

It is important to note that although the paper's findings would appear to be transferrable to other UK cities and beyond, further research may demonstrate other findings due to socio-cultural differences. Because of the relatively small sample sizes employed, these observations should be understood as time- and location-specific indicative findings rather than overarching generalisations or anything more definitive. Further research in the field would therefore be encouraged.

Conclusion

This paper has explored and compared the opinions of owners/occupiers both with and without green roofs, in attempting to understand more about the blockages and potentials for increasing uptake. The study confirmed for a specific UK context (the Newcastle CBD) the lack of awareness and understanding of green roofs mentioned with reference to literature from around the world in the Introduction.

The opinions of green roof owners, whilst somewhat mixed, were found to overall be very positive about the wider value of such roofing and no respondent said they would not choose the same approach again. Interviewees tended to recognize many of the multiple potential benefits, both at building-level and beyond, and seemingly considered extra building-level costs as of little concern. None would appear to have prioritized cost-benefit analyses or externally-facing brand image when considering such roofs; rather, this was a matter of consistency with organizational identity. For those without green roofs, it was apparent that lower awareness and understanding were leading respondents to focus upon building-level risks and costs of roofing, under-estimating, not considering or not valuing the multiple potential benefits at building-level and beyond. This understandably tended to skew preferences towards a more conservative position.

If authorities were to wish to increase green roof uptake, several stages of activity might therefore be required: firstly, much wider conversations around environmental citizenship and the societal *value* of green roofs over and above their direct building-level costs and benefits; secondly, significant preliminary work around awareness and understanding concerning building-level costs, risks and benefits; thirdly, a series of policy decisions around the distribution of benefits and so fair allocation of costs, and subsidies, and finally, a number of high-profile exemplar projects to demonstrate their practicability and effectiveness. All of these would be designed to begin shifting ideas around the possibility,

plausibility and desirability of pursuing green infrastructure atop of the existing built environment.

The number of potential benefits of green roofing at wider neighbourhood and societal levels are multiple, and some area benefits (such as providing wildlife corridors and so hopefully improving biodiversity) will only emerge through their multiplicity and proximity. Green roofs are seemingly not currently on the radar of business owners/occupiers, so responsibility lands strongly on the shoulders of local and national government, possibly in partnership with bodies such as Business Improvement Districts, to push the conversation forwards.

References

Ajzen, Icek (1991), "The theory of planned behavior", *Organizational Behavior and Human Decision Processes*, Vol. 50 No. 2, pp. 179–211.

Bianchini, F. and Hewage, K. (2012), "Probabilistic social cost-benefit analysis for green roofs: A lifecycle approach", *Building and Environment*, Vol. 58, pp. 152–162.

Commission for Architecture and the Built Environment [CABE] (2011), "Using green infrastructure to alleviate flood risk", available at: http://webarchive.nationalarchives.gov.uk/20110118143000/http://www.cabe.org.uk/sustainable-places/advice/green-infrastructure-and-flood-risk (accessed 12 June 2015).

Castleton, H. F., Stovin, V., Beck, S. B. M. and Davison, J. B. (2010), "Green roofs: Building energy savings and the potential for retrofit", *Energy and Buildings,* Vol. 42**,** pp. 1582-1591.

Claus, K. and Rousseau, S. (2012), "Public versus private incentives to invest in green roofs: A cost benefit analysis for Flanders", *Urban Forestry and Urban Greening*, Vol. 11 No. 4, pp. 417–425.

Ding, L., Van Renterghem, T., Botteldooren, D., Horoshenkov, K., and Khan, A. (2013), "Sound absorption of porous substrates covered by foliage: Experimental results and numerical predictions", *The Journal of the Acoustical Society of America*, Vol. 134 No. 6, pp. 4599–4609.

Dobson, A. (2007), "Environmental citizenship: Towards sustainable development", *Sustainable Development*, Vol. 15 (September), pp. 276-285.

Environment Agency (2014), "Sheffield lower don valley FAS: Profiling partnership funding", available at: https://khub.net/c/document_library/get_file?uuid=53d89884-9d88-4d64-b36d-f09dd24ccdbc&groupId=6084608 (accessed 20 September 2016).

Fernandez-Cañero, R., Emilsson, T., Fernandez-Barba, C., and Machuca, M. Á. H. (2013), "Green roof systems: A study of public attitudes and preferences in southern Spain", *Journal of Environmental Management*, Vol. 128 (C), pp. 106–115.

Fioretti, R., Palla, A., Lanza, L. G., and Principi, P. (2010), "Green roof energy and water related performance in the Mediterranean climate", *Building and Environment*, Vol. 45 No. 8, pp. 1890–1904.

Gill, S. E., Handley, J. F., Ennos, A. R. and Pauleit, S. (2007), "Adapting cities for climate change: The role of green infrastructure", *Built Environment*, Vol. 33 No. 1, pp. 115-133.

Glaser, B. G. and Strauss, A. L. (2009), *The Discovery of Grounded Theory*, Aldine Transaction, Piscataway, NJ.

Gordon-Walker, S., Harle, T., and Naismith, I. (2007), *Cost-Benefit of SUDS Retrofit in Urban Areas* (Science Report SC060024), Environment Agency, Bristol.

Hechter, M. and Kanazawa, S. (1997), "Sociological rational choice theory", Annual Review of Sociology, Vol. 23, pp. 191-214.

Hendricks, J. S. and Calkins, M. (2006), "The adoption of an innovation: Barriers to use of green roofs experienced by midwest architects and building owners", *Journal of Green Building*, Vol. 1 No. 3, pp. 148–168.

Hilal, A. H. and Alabri, S. S. (2013) "Using NVivo for analysis in qualitative research", *International Interdisciplinary Journal of Education*, Vol. 2 No. 2, pp. 181-186.

Hoang, L., and Fenner, R. A. (2014), "System interactions of green roofs in blue green cities", paper presented at the 13th International Conference on Urban Drainage, Sarawak, Malaysia, available at: http://www.bluegreencities.ac.uk/documents/hoangfenner-icud2014-green-roofs.pdf (accessed 20 February 2015).

Hoffman, A. J., and Henn, R. (2008), "Overcoming the social and psychological barriers to green building", *Organization and Environment*, Vol. 21 No. 4, pp. 390–419.

Jha, A., Lamond, J. E., Bloch, R., Bhattacharya, N., Lopez, A., Papachristodoulou, N., Bird, A., Proverbs, D., Davies, J. and Barker, R., (2011), "Five feet high and rising - cities and flooding in the 21st century", Policy Research Working Paper 5648, The World Bank, Washington.

Jungels, J., Rakow, D. A., Allred, S. B., and Skelly, S. M. (2013), "Attitudes and aesthetic reactions toward green roofs in the Northeastern United States", *Landscape and Urban Planning*, Vol. 117 (September), pp. 13–21.

Kalantari, M., Ghezelbash, S., and Yaghmaei, B. (2016), "People and green roofs: Expectations and perceptions of citizens about green roofs development, an Iranian case study", *Mediterranean Journal of Social Sciences*, Vol. 7 No. 2, pp. 1–10.

Klimkiewicz, K. and Oltra, V. (2017), "Does CSR enhance employer attractiveness? The role of millennial job seekers' attitudes", *Corporate Social Responsibility and Environmental Management***,** Vol. 24 No. 5, pp. 449-463.

Lamond, J. E., Wilkinson, S. J., Rose, C., and Proverbs, D. G. (2014a), *Sustainable Urban Drainage – Retrofitting for Improved Flood Mitigation in City Centres*, Project Report, Royal Institution of Chartered Surveyors, London.

Lamond, J. E., Wilkinson, S. and Rose, C. (2014b). "Conceptualising the benefits of green roof technology for commercial real estate owners and occupiers", paper presented at Resilient Communities, Providing for the Future, 20th Annual Pacific Rim Real Estate Conference, Christchurch, New Zealand, available at: http://eprints.uwe.ac.uk/22536/ (accessed 15 January 2015).

Liu, M. T., Wong, I. A., Shi, G., Chu, R., and Brock, J. L. (2014), "The impact of corporate social responsibility (CSR) performance and perceived brand quality on customer-based brand preference", *Journal of Services Marketing,* Vol. 28 No. 3**,** pp. 181-194.

Loder, A. (2014), "'There's a meadow outside my workplace': A phenomenological exploration of aesthetics and green roofs in Chicago and Toronto", *Landscape and Urban Planning*, Vol. 126 (June), pp. 94–106.

Loussaïef, L., Cacho-Elizondo, S., Pettersen, I. B. and Tobiassen, A. E. (2014), "Do CSR actions in retailing really matter for young consumers? A study in France and Norway", *Journal of Retailing and Consumer Services,* Vol. 21 No. 1, pp. 9-17.

Marshall, M. N. (1996) Sampling for qualitative research, *Family Practice*, Vol. 13 No. 6, pp. 522-525.

Mentens, J., Raes, D., and Hermy, M., (2006). Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century? *Landscape and Urban Planning*, *77*(3), 217–226.

Nappi-Choulet, I., and Labussière, S. (2015). Greening up our cities: Bringing new value to new spaces in the Paris region. *Corporate Real Estate Journal*, *5*(1), 57–68.

Nelms, C. E., Russell, A. D., and Lence, B. J. (2007). Assessing the performance of sustainable technologies: a framework and its application. *Building Research & Information*, *(35)*3, 237-251.

Oberndorfer, E., Lundholm, J., Bass, B., Coffman, R. R., Doshi, H., Dunnett, N., Gaffin, S., Köhler, M., Liu, K. K. Y. and Rowe, B., (2007). Green roofs as urban ecosystems: Ecological structures, functions, and services. *BioScience,* 57**,** 823-833.

O'Donnell, E., Woodhouse, R. and Thorne, C. (2017) Evaluating the multiple benefits of a sustainable drainage scheme in Newcastle, UK. *Proceedings of the ICE – Water Management*, 1-12. Retrieved from http://www.icevirtuallibrary.com/doi/pdf/ 10.1680/jwama.16.00103

Olubunmi, O. A., Xia, P. B., and Skitmore, M., (2016). Green building incentives: A review. *Renewable and Sustainable Energy Reviews*, *59*(C), 1611–1621.

Pregnolato, M., Ford, A., Glenis, V., Wilkinson, S., and Dawson, R. (2017). Impact of Climate Change on Disruption to Urban Transport Networks from Pluvial Flooding. *Journal of Infrastructure Systems*, *23*(4). Retrieved from http://eprint.ncl.ac.uk/file_store/production/ 238460/99D551E6-3C06-4911-A8DD-97DCCC07F3E1.pdf

Scott, J. (2000), "Rational choice theory", in Browning, G., Halcli, A. and Webster, F. (Eds.), *Understanding Contemporary Society: Theories of the Present*, SAGE, London, pp. 126-138.

Norazah Mohd Suki, Norbayah Mohd Suki, (2015) "Consumers' environmental behaviour towards staying at a green hotel: Moderation of green hotel knowledge", *Management of Environmental Quality: An International Journal*, Vol. 26 Issue: 1, pp.103-117

Tassicker, N., Rahnamayiezekavat, P., and Sutrisna, M., (2016). An Insight into the Commercial Viability of Green Roofs in Australia. *Sustainability*, *8*(7), 603–25.

Tayouga, S., and Gagné, S., (2016). The Socio-Ecological Factors that Influence the Adoption of Green Infrastructure. *Sustainability*, *8*(12), 1-17.

UN [United Nations Department of Economic and Social Affairs, Population Division]. (2014). *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352)*. New York: United Nations.

Welsh, Elaine (2002). Dealing with Data: Using NVivo in the Qualitative Data Analysis Process [12 paragraphs]. Forum: Qualitative Social Research, 3(2), Art. 26, http://nbn-resolving.de/urn:nbn:de:0114-fqs0202260

Wengraf, T. (2001). Qualitative Research Interviewing. London: SAGE.

Wheater, H. and Evans, E., (2009). Land use, water management and future flood risk. *Land Use Policy, 26*(1)**,** 251-264.

Wilkinson, S. J., Goddard, J. G., Croft, L., Fisher, M., Willers, M., and Paul, M. (2016) *Green Roofs and Walls*. RICS Professional Guidance, Australia. London, UK: RICS.

Wilkinson, S. J., Lamond, J. E., Proverbs, D. G., Sharman, L., Heller, A., and Manion, J. (2015). Technical considerations in green roof retrofit for stormwater attenuation in the Central Business District. *Structural Survey*, *33*(1), 36–51.

Wilkinson, S. J. and Orr, F. (2017) The impact of horticulture therapy on mental health care consumers on a retrofitted roof, paper presented at the 23rd Annual Pacific Rim Real Estate Conference, Sydney, New South Wales, Australia, 15-18th January 2017.

Wilkinson, S. J. and Reed, R., (2009). Green roof retrofit potential in the central business district. *Property Management, 27*(5)**,** 284 - 301.

Wolf, J. F. (2006). Urban governance and business improvement districts: The Washington, DC BIDs. *International Journal of Public Administration*, *29*(1-3), 53–75.

Wong, N. H., Wong, S. J., Lim, G. T., Ong, C. L., and Sia, A. (2005). Perception study of building professionals on the issues of green roof development in Singapore. *Architectural Science Review*, *48*(3), 205–214.

Wong, T. H., and Eadie, M. L., (2000). *Water sensitive urban design: A paradigm shift in urban design*. Paper presented at the 10th World Water Congress: Water, the Worlds Most Important Resource, Sydney.

Wright, G. B., Arthur, S., Bowles, G., Bastien, N., and Unwin, D. (2011). Urban creep in Scotland: stakeholder perceptions, quantification and cost implications of permeable solutions. *Water and Environment Journal*, *25*(4), 513–521.

Wu, S. R. Greaves, M., Chen, J. and Grady, S. C. (2017) "Green buildings need green occupants: a research framework through the lens of the Theory of Planned Behaviour", *Architectural Science Review*, Vol. 60 No. 1, pp. 5-14.

Yuen, B., and Nyuk Hien, W. (2005). Resident perceptions and expectations of rooftop gardens in Singapore. *Landscape and Urban Planning*, *73*(4), 263–276.

Zahir, M. H. M., Raman, S. N., Mohamed, M. F., Jamiland, M., and Nopiah, Z. M. (2014).

The perception of Malaysian architects towards the implementation of green roofs: A review of practices, methodologies and future research. Paper presented at *E3S Web of Conferences*. Retrieved from https://www.e3s-conferences.org/articles/e3sconf/pdf/2014/02/e3sconf_ etsdc2014_01022.pdf

Zhang, X., Shen, L., Tam, V. W. Y., and Lee, W. W. Y. (2012). Barriers to implement extensive green roof systems: A Hong Kong study. *Renewable and Sustainable Energy Reviews*, *16*(1), 314–319.