INCREASING THE USE OF RECLAIMED AND RECYCLED
BUILDING MATERIALS IN NEW ZEALAND:
STAKEHOLDER PERCEPTIONS

BY

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Abstract

This study investigated the perceptions of stakeholders in the building construction industry regarding the use of reused and recycled building materials (RRBMs) as a sustainable action in terms of using fewer natural resources and generating less waste. The aim was to find challenges to and opportunities for using RRBMs and provide recommendations for the relevant actors. Different occupations participated in this study including architects and designers, builders, manufacturers and suppliers, environmentalists, regulators and consumers. An explanatory-sequential, mixed-method approach was used to collect quantitative data and explore these more deeply with qualitative data to answer the research questions. The involvement of many different stakeholders was helpful in creating a multidimensional conceptualisation towards reaching sustainable construction goals. The roles, expectations, interrelationships, and demands of stakeholders were identified. The architect was perceived to be most influential construction industry stakeholder in the building project team on the uptake of RRBMs. The aim of this study was to create a big picture of the situation to show to decision-makers and other relevant audiences and give suggestions that could help to increase the use of RRBMs and ultimately lower the environmental impacts of buildings in New Zealand.

The groups of stakeholders had different levels of environmental attitudes, although the mean score was in the pro-ecological range. Education level, occupation and ownership of property also influenced environmental attitudes. Of the stakeholders not directly associated with environmental activism, the architects had more environmentally friendly attitudes. Analysing the behaviour of stakeholders in terms of socio-demographic data and occupation indicated that women and people with tertiary education were more likely to engage in reuse and recycling activities and occupation also had an influence on this. Consumers had the least and architects the most knowledge of regulations and certification in this area.

Examining the Theory of Planned Behaviour showed that architects with higher environmental attitude scores had stronger intentions to do more recycling or buy more recycled materials; however, their intentions were also influenced by factors affecting green purchase behaviour. Knowledge of related regulations and certificates also influenced their behaviour. Although the behavioural models differed for the other stakeholder groups, environmental attitudes and

perceived behavioural control were strong predictors of behaviour involving reuse and recycling and particularly the use of RRBMs for all groups.

Price and self-satisfaction were the most influential factors on green purchasing in this study, although age, gender, and income were also influential. The results of the quantitative and qualitative studies were different in the evaluation of material characteristics. In the qualitative results it was felt cost was most important whereas, in the quantitative results, it was felt performance and durability were most important.

Architects and regulators emerged as the two most important stakeholder groups who could both lead and influence other stakeholders regarding the increased use of RRBMs in projects. In this situation, architects could have a leading role as decision-makers in the process of choosing a material, and could both inform and encourage the client to use RRBMs. Architects were also in a position to do the necessary research about such materials, and ask for supporting documents and certifications from manufacturers and suppliers.

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Glossary

RRBM	Reclaimed and recycled building material
C&D	Construction and demolition
MfE	Ministry for the Environment
REBRI	Resource Efficiency in Building and Related Industries
TPB	Theory of Planned Behaviour
NEP	New Environmental/Ecological Paradigm
PBC	Perceived Behavioural Control
SN	Subjective Norm
Int	Intention
Beh	Behaviour

1 Introduction

1.1. Statement of the problem

Moving toward a more sustainable world is imperative for the survival of humankind, and the situation invites all actors to play their part. Actors are all those who have a role in this, including individuals, firms, and decision-makers. In theory, economies can grow forever if resources are not limited but this is not the case on a finite planet. Transformational strategies have proven that reductions in the amount of natural resources used and waste generated are inevitable (Parkes & Borland, 2012). In the construction industry, treating waste as a valuable resource is an opportunity that construction industry stakeholders, such as architects and builders, could consider. A circular resource flow can be defined as a system that generates minimal waste, where waste from one industrial activity is treated as an input for other activities. This transformation needs a level of preparation in terms of infrastructure, technical breakthroughs and the creation of an appropriate regulatory environment (Dominish et al., 2017). It is still a controversial issue as to which of these is the more effective driving force behind such environmental improvements (Sandhu, Ozanne, Smallman, & Cullen, 2010) and as many diverse professions with different roles and responsibilities are found in the building industry, an understanding of their environmental attitudes, awareness and level of engagement with resource and waste reduction could be beneficial (Bhate, 2002; Dunlap, Van Liere, Mertig, & Jones, 2000; Rodriguez-Melo & Mansouri, 2011).

The building construction industry is undergoing a surge due to population growth in New Zealand, which means more building projects and increasing detrimental effects on the environment. The annual growth rate of the population in New Zealand is 1.7%, mostly due to immigration (Figure 1), and the number of buildings is increasing because of this growth (Figure 2). This leads to an increasing demand for building materials, most of which are based on virgin natural resources (MacPherson, 2016a, 2016b). Statistics indicate that the volume of building activity has doubled from 2011 (MacPherson, 2016b). As the construction industry utilises a large amount of energy and materials, it is also responsible for a large portion of wastes. Addis (2012) states that if humanity continues to generate waste as before, the resources of more than three earths will be necessary for humanity to survive. Additionally, as Iacovidou & Purnell (2016) found in their research, a significant share of CO₂ emissions, and the consequent effect on climate change, can be attributed to the production of building materials specifically steel, concrete (cement), and timber. Most of

the environmental impacts of common building materials like concrete arise through their production. Revising the material and resource flow is thus an urgent and necessary response to pressures on the environment from the growing human population and need to have more buildings (Iacovidou & Purnell, 2016).

Figure 1. Estimated resident population of New Zealand (Statistics New Zealand, 2020b)

Figure 2. New dwellings consented in New Zealand (Statistics New Zealand, 2020a)

Zero-waste New Zealand director Jo Knight said that each year each New Zealander generates 734kg of waste and this had increased by around 20 per cent over the past three years (RNZ, 2018b). The categories of waste are shown in Figure 3, but unfortunately these statistics have not been updated since 2004 (Statistics New Zealand, 2004). However, as timber and C&D waste are among the main categories of landfill wastes (Tim Denne & Bond-Smith, 2012), a future focus of New Zealand waste management is reducing the quantity of these valuable wastes going to landfills (MfE, 2007).

C&D waste makes up to 50% of all waste generated in New Zealand (Greater Wellington Regional Council, 2012) and based on a report by Resource Efficiency in Building and Related Industries (REBRI), the composition of a typical construction skip is 20% wood and particleboard, 13% plasterboard, 12% concrete and brick, 5% metal, 5% packaging and 45% other materials (REBRI, 2014b).

A small portion of waste is currently recycled (Bahamón, 2010) and promoting positive examples of reusing and recycling materials is needed in the building industry (Addis, 2012). For example, in the NZ construction industry, ready-mix concrete produces 260,000 tons of waste concrete annually, which is equal to the concrete required to build seven skyscrapers (Envirocon, 2015). Based on a report by the Centre for Advanced Engineering (CAE) (2003), a new car in New Zealand may have 70% recycled material. Nevertheless, despite the depletion of natural resources and consequent increasing costs, buildings and roads have less than 1% recycled content. For a 100% recycled road, the related costs could be higher, but taking disposal costs into consideration would lower the costs and bring savings for the project (Slaughter, 2013).

Figure 3. Composition of waste disposed to landfills in 2004 (Statistics New Zealand, 2004)

As noted above, nearly 50% of waste streams in New Zealand come from construction demolition sites, a figure not dissimilar to the global proportions of construction waste (REBRI, 2009). Earlier studies indicate that in New Zealand 80% of the waste from construction processes go to clean-fills (REBRI, 2009). Clean-fill is used for disposing of materials that are free from contaminants that may

cause harm to people and the environment. Usually, these materials are virgin natural materials, and other inert materials, so they have the potential to be reused or recycled (MfE, 1991).

A report by REBRI (2008) states that designers, architects, and engineers can have a significant influence on waste reduction during the design stages of a project. However, there are always constraints against fulfilling this goal, and the New Zealand context has its own limitations. For example, the fact this national target is not mandatory, the time and therefore cost of planning for waste minimisation, and the availability of plentiful timber (Conder, 2008).

In conclusion, the growing population in New Zealand leads to an increasing number of building projects and the need for building materials and results in the increasingly detrimental effects of waste. One solution to this problem is the use of reused and recycled building materials (RRBMs) and having a more sustainable building construction sector with this approach requires studying the attitudes and behaviour of construction industry stakeholders in order to make recommendations for change.

1.2. Significance

Reuse and recycling were the norms before the 19th century, and many materials and components which remained from destroyed or old buildings were reused if they were still in good condition or scarce and/or valuable (Addis, 2012). Another issue is that discarded garbage remains potentially harmful to humans through contamination of soil, water and air (Bahamón, 2010). The environmental impacts of increasing waste are depletion of non-renewable resources, increasing air and water pollution, and losing natural landscapes and habitat (Addis, 2012). Material substitution as a strategy for reducing the energy embodied in building materials, such as substituting a high embodied energy material with a lower one, for example a timber rather than steel structure in residential buildings, can be a positive approach to reducing the use of natural resources. Even more energy could be saved when this substitution is with RRBMs. The effect of increasing the recycling potential of buildings at the design stage, to make deconstruction and salvage easy, could also result in a considerable reduction in building life-cycle energy use. How big these reductions might differ in case studies due to the different recycling forms, rates and composition of the materials (Thormark, 2006).

Based on a communication from the European Commission to the European Parliament, entitled *Roadmap to a Resource Efficient Europe* and authored by the Council, the European Economic and Social Committee and the Committee of the Regions, the construction industry uses more resources and generates more waste than other industries (European Commission, 2011), so this gives this industry a pivotal role in the transition to a circular economy (Migliore, Talamo, & Paganin, 2019). Recycling in the construction industry could change the flow of mass-produced waste to landfills significantly.

As the modern way of life, and the built environment that it fosters, plays a large part in the ongoing degradation of the environment, it also seems that understanding people's attitudes and behaviours toward environmental issues could be a starting point for change. With this in mind, a number of different scales have been developed over the past 45 years to gauge people's environmental attitudes, knowledge and behaviour (Khan, Khan, & Adil, 2012). Dunlap describes the environmental worldview as a "person's belief about humanity's relationship with nature" (Dunlap, 2008). While the ecological worldviews of many parts of society are changing in light of the need to move towards a more sustainable future, these will need to evolve further. One aspect of a move towards sustainability is the evolution of the system of which we are part (Du Plessis & Brandon, 2015), and in the context of this research, this system includes all building construction processes. All stakeholders in the construction industry play vital roles in this overall system, and it is, therefore, essential to understand their ecological worldviews.

The demand for RRBMs is directly and indirectly dependent on government policies, clients, designers, contractors and developers (Addis, 2012). Recycled content products have been called 'green' due to the reduced energy consumption during the production phase (Albino, Balice, & Dangelico, 2009). However, the meaning of 'green' can change according to the field of study. One definition is "green is a product (tangible or intangible) that minimizes its environmental impact (direct and indirect) during its whole life cycle, subject to the present technological and scientific status." (Sdrolia & Zarotiadis, 2019). Using green products matches with human nature based on consumer perspectives as few people deliberately set out to destroy the environment (Lemke & Luzio, 2014). Decisions made by a society dictate (or define) the values in the market and the preferences for sustainable products and ultimately a sustainable future. In other words, when a society prefers green products, commitment to producing these is easier for companies (Rodriguez-Melo & Mansouri, 2011). From the perspective of the gap in the knowledge, there should be more research on how to promote and encourage C&D waste reduction by creating the desire for green

building products. This implies studying cooperation, communication, and the mind-set of construction industry stakeholders (see section 3.4).

The factors that influence client decision-making processes are not well understood. Based on the studies of Addis (2012), the reasons behind reuse and recycling can be divided into three groups for the design team: reducing environmental impacts; increasing benefits for the project that come from reduced material costs, reduced transportation costs and reduced disposing costs; and improving the reputation of the design and construction team.

From another point of view based on the recommendations of previous studies, focusing on one sector in one geographical area (Albino, Balice, & Dangelico, 2009), one specific industry (because of different industry motivations) (Paulraj, 2009), and on specific products (to avoid vagueness) (Haryanto & Budiman, 2015) should improve the quality, generalisation and reliability of the outcomes.

Further to this, studying the perceptions of stakeholders in the building construction industry could show a different pattern from other industries, because the role played by architects and designers in increasing the uptake of RRBMs has not yet been studied completely, at least in New Zealand. In conclusion, this research topic seems worthy of being studied, and is relevant and necessary.

1.3. Statement of Purpose

There are three sorts of opportunities for using RRBMs in building projects:

- reusing in-situ (a component or a whole building which is still usable in the existing location to avoid waste, and use of raw materials and energy);
- reusing salvaged, reconditioned and reclaimed materials elsewhere (when there is a possibility of using components in another location); and
- using recycled content building materials (waste materials can be used as the resources of new products) (Addis, 2012) (Figure 4).

This research is aimed at providing insights from construction industry stakeholder on the uptake of RRBMs in the New Zealand building construction industry. These insights concern the challenges to and opportunities for using RRBMs, in order to offer recommendations on what needs to change to encourage their greater use. The ambiguity in the perceptions of stakeholders about their roles,

expectations, interrelationships, and demands will be explored and documented. The research aims to identify the most influential stakeholder(s) behind future increases in the use of recycled building materials, and any existing constraints on them.

Figure 4. Examples of reuse and recycling;

- 1) top left: using glass bottles to make a wall, (2012). retrieved from <https://inhabitat.com/raumlabor-officina-roma-is-a-villa-built-entirely-from-trash-by-kids/>,
- 2) top right: using rotor blades to make a play ground, (2014). Retrieved from <https://www.cubesmart.com/blog/post/worlds-amazing-playgrounds-made-recyclables/>,
- 3) bottom left: recycling plastic to make blocks, (2018). Retrieved from <https://www.expertskiphire.co.uk/plastic-bricks>,
- 4) bottom right: making blocks with rice husks, (2019). Retrived from <https://www.gercona.com/en/resysta/material/>.

This study was conducted based on an explanatory sequential, mixed-method research design (see chapter 3). This involved collecting quantitative data from stakeholders through a survey in selected cities of New Zealand and then exploring and explaining the quantitative results by using in-depth qualitative data collected from focus groups and interviews.

Involving a range of construction industry stakeholders can be helpful in creating a multidimensional conceptualisation towards a more sustainable approach (Luchs, Phipps, & Hill, 2015). The classification of questions to respondents about their motivations, awareness and experiences (Figure 5) (see section 5.1.1.4.3) should lead to a deeper understanding of the relationships between the different factors studied. Hopefully, the results and recommendations based on these will help

stakeholders have a broader perspective so as to better understand the situation and make decisions accordingly.

1.4. Contribution

The potential significance of this study has been noted above in that the construction industry uses more resources and generates more waste than other industries. This gives this industry a pivotal role in the transition to a circular economy. Understanding people's attitudes and behaviours toward environmental issues, especially people in the construction industry, could be a starting point for this change. This is the gap in knowledge addressed by this thesis. One of the obstacles against waste minimisation recognised in the literature is the lack of cooperation, poor communication, and the mind-set of stakeholders. This has not been studied enough in the construction industry in New Zealand and there is a lack of national literature on these issues.

This study aims to add to the literature in this area by measuring stakeholder environmental orientations and the factors influencing their uptake of RRBMs. In other words, this study sets out to discover the driving forces behind increasing the use of RRBMs for each stakeholder group. This knowledge could lead to the effective promotion of RRBMs to the different stakeholders through finding the model of behaviour of each group. Relevant recommendations can therefore be made in an attempt to increase the use of RRBMs in the New Zealand building industry.

1.5. Research question

This study started with a general and overarching question. The topic was further explored through sub-questions. The primary research question is:

- What are the perceptions of different stakeholders regarding the use of RRBMs?

Secondary questions are:

- How can the attitudes of stakeholders be influential on the future use of RRBMs?
- How may a diversity of perceptions shape the role of architects?

1.6. Research Plan

This research is divided into three parts: planning, data collection and analysis, and recommendations (Figure 5). The planning is shaped around a literature review with the intention of following the rich vein of knowledge left by other researchers in the field. Data collection is through a mixed-method approach including an online survey, focus groups and interviews (see chapters 3, 4 and 6). It is an explanatory sequential process, as after obtaining quantitative results they will be explained in more detail through the focus group and interview voices to help understand mechanisms behind trends in the quantitative results (Creswell & Clark, 2007). Recommendations are implied from the results of this study. This plan, taking the form of a research framework, is further discussed in chapter 4 (methodology), chapter 2 and 3 (literature review) and chapter 10 (conclusion).

Figure 5. The initial framework of the study

2 Literature review_ Part One: The Waste Problem

2.1 Introduction

Treating waste as a valuable resource is an opportunity for all producers, manufacturers, and stakeholders. To meet Goal 12 of the United Nations Sustainable Development Goals (responsible consumption and production) will require those involved to do more and better with less. In turn this will lead to reducing waste generation through prevention, reduction, recycling and reuse. This transformation can be prepared for in areas such as appropriate infrastructure, technical breakthroughs, and a waste preventing regulatory environment. Internationally, there is increased activity by a range of interested parties toward preparing for such transformations (Dominish et al., 2017).

The construction industry is one of the most polluting industries, not only in New Zealand but also throughout the rest of the world. In terms of creating waste, C&D activities generate almost half of the waste by weight produced in New Zealand and most of this is transported to cleanfill sites. As most of this waste is free of contaminants, it could also be reused or recycled in some way. In other words, not only can the construction industry conserve natural resources by recovering them, but it can also prevent the environmental effects caused by throwing them away (Greater Wellington Regional Council, 2019). The biggest components of this waste are timber, plasterboard, and concrete and 81% of these materials are from construction and demolition sites (REBRI, 2014a).

The adverse effect of products cannot be seen by consumers at the time of purchase, especially when the wider effects on other countries are included. However, research for the New Zealand MfE indicated that 50% of people are worried about these adverse effects. This response may have arisen due to the high figures in producing certain wastes in New Zealand, such as e-waste or micro-plastics, compared to overseas (MfE, 2018). A circular economy approach (see section 2.1.1), which involves making products with careful use of natural resources and consideration given to end of life reuse and recycling options, can provide part of the solution to this problem.

In 2005 the national target of the New Zealand government was to reduce C&D waste by 50% by 2008 (Conder, 2008). There is no updated information regarding waste minimisation targets. The government is still working on different ways to reduce waste and design it out of the system, including working on a waste disposal levy, collecting data on the composition of waste, identifying which waste types are most harmful to the environment, creating product stewardship for wastes,

investing in the required infrastructure, and all specifically for the sectors that can benefit more. Overall, these actions are supporting a circular economy (MfE, 2018). Each month New Zealanders dispose of enough rubbish to fill a rugby field up to a height of 30 storeys. Household rubbish accounts for 1.05 million tonnes each year based on a MfE report. Up to two-thirds of all household rubbish can be reused or recycled, thus reducing carbon emissions, energy consumption, resource depletion and disposal costs. Also, considering half of the wastes going to landfill are C&D waste, the importance of reuse and recycling in this sector is obvious (MfE, 2009a).

Some of the items in the current government plan to improve recycling include educating people on “recycle right”, providing more transparent information on materials, and encouraging the purchase of RRBMs. These guidelines and other similar ones came into being after the 2017 Chinese Government’s ban on importing some materials and waste products, including low-quality plastics (MfE, 2018).

The main governmental effort to reduce waste is the Waste Minimisation Act (WMA). The WMA is legislation related to and supportive of the use of RRBMs. This Act encourages waste reduction in order to mitigate the adverse effect of its environmental, economic, and socio-cultural aspects (MfE, 2018).

Responsibilities incurred by the government under the Waste Minimisation Act include charging a waste disposal levy, funding waste minimisation projects, funding city and district councils to promote waste minimisation using the levy money, overseeing product stewardship, regulating the environmental impacts of products, supporting the Waste Advisory Board, and promoting Public Place Recycling (MfE, 2018). One of the key areas the government could focus on to improve housing affordability is the cost of building materials as these could be lowered by the use of RRBMs.

In construction, many of the materials and components that are used have considerable environmental impacts. Material waste is becoming a critical problem in large cities, and as the construction industry is one of the main contributors—half of the waste generated in cities is from construction—efforts to reduce these amounts could be beneficial. To this end, the use of RRBMs is becoming popular, especially when it comes to a sustainable building project (Richardson, 2013). Reducing C&D waste through different approaches (Jaillon, Poon, & Chiang, 2009; Kartam, Al-Mutairi, Al-Ghusain, & Al-Humoud, 2004; Tam, Tam, Zeng, & Ng, 2007; Wong & Yip, 2004) and recycling of building materials (Amponsah, Lacarrière, Jamali-Zghal, & Le Corre, 2012; Nautiyal, Shree, Khurana, & Kumar, 2015; Solís-Guzmán et al., 2015), especially the most important ones such

as concrete (S.-H. Chen, Wang, & Jhou, 2013; Siddique, 2008; Xiao & Ding, 2013) and timber (Cavalli, Cibecchini, Togni, & Sousa, 2016; Ling & Leo, 2000; Murta et al., 2011; Richardson, 2013) have been the subject of many studies.

2.1.1 Circular economy

According to the UK Ellen MacArthur Foundation, the principles of the circular economy are to design out waste and pollution, keep products and materials in use as long as possible, and regenerate natural systems. Our current ways of production are reaching its limit. The linear economy is no longer a good response to the environment or to business. In a circular economy, waste is a design flaw that can be solved by good design so the product can be reused, repaired and remanufactured. This shift in the design of the system demands involvement by all actors (Ellen MacArthur Foundation, 2019).

The focus of a circular economy is to imitate biological systems in production and consumption. A circular resource flow means a system with minimal waste where waste from one industrial activity is treated as input for other activities (Dominish et al., 2017). Another definition for a circular economy describes it as a regenerative system with minimum waste, emissions, and energy leakage (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). Closing the loop of resource flows puts the focus on recycling, remanufacture, repair, and reuse (Dominish et al., 2017; Parkes & Borland, 2012).

In order to support businesses with a circular economy approach, there are a number of voluntary product stewardship schemes related to building construction in New Zealand. These currently include Envirocon, Interface ReEntry Programme, and Paintwise. Buying materials with recycled content would be a good way to help these programmes grow. Other reasons for buying RRBMs are extracting fewer natural resources, reducing energy demand, increasing the demand for recyclables, and self-satisfaction, as well as supporting the circular economy (MfE, 2018).

2.1.2 Sustainable Development Goals

Several environmental disasters in the 1970s and 80s served to raise environmental consciousness in people, including many researchers. Governments have also responded as well as the United Nations (UN). The UN's Sustainable Development Goals (SDGs) are a set of 17 targets for 2030 that

can be measured with indicators (Secher, Collin, & Linnet, 2018). Among these, Target 12 is “responsible consumption and production.” Applying this to the building industry implies questioning how materials are produced and what happens to them at the end of their life. In this regard, environmentally conscious consumers in the construction market could play an important role that could lead to increased demand for environment-friendly building products. Having an environment-friendly built environment, of which the materials are a vital part, has also been claimed as having both a direct and indirect influence on SDGs three (good health and well-being), six (clean water and sanitation), seven (affordable and clean energy), eight (decent work and economic growth), nine (industry, innovation and infrastructure), and eleven (sustainable cities and communities) (Secher et al., 2018). A number of SDG indicators can be addressed through the process of building materials production (United Nations Statistics Division, 2019) (Table 1).

Table 1. SDG indicators which can be addressed through the use of RRBMs

Indicator number	Description
3.9	reducing health risks from pollution and contamination of resources
6.3	reducing water pollution caused by dumping chemicals and materials
6.4	water-use efficiency across the industry (production and construction)
7.3	increasing the energy efficiency of the production process
8.3	supporting job creation, creativity and innovation
8.4	resource efficiency in the production process in order to have economic growth with less environmental degradation
8.9	promoting local cultures and products
9.1	developing sustainable infrastructure
9.4	supporting retrofit industries with efficient resource-use and clean technologies
11.1	access to affordable housing
11.4	protecting cultural and natural heritage
11.6	proper waste management to have cities with less adverse environmental impacts
12.1	implementing Sustainable Consumption and Production Patterns
12.2	managing to have sustainable and efficient use of natural resources
12.4	reducing adverse environmental impacts of waste on human health and environment
12.5	waste reduction through prevention, reduction, recycling and reuse
12.8	educating people to have sustainable lifestyles

2.2 Waste minimisation in construction

Waste reduction and management plays an important role in moving towards sustainability and since construction waste forms a major share of total waste, it has a corresponding a role in decreasing total waste at the different stages of the construction process wherever this is possible (Li, Tam, Zuo, & Zhu, 2015). Typical categories of C&D waste are timber, plasterboard, metal, concrete, and rubble as well as packaging, unwanted plants, and soil. As Jaques (2008) stated, since 1995 there has been no reliable data to show the percentage of different types of C&D waste for

New Zealand. In a report based on the visual assessment of 20 Auckland building sites, a rough estimate shows that a new build residential project generates 3-3.5 tonnes of waste. In New Zealand, around 18% of building construction projects are residential renovations that generate 8% of all C&D waste (Jaques, 2018). In the UK, construction activities are generating half of the CO₂ emissions and one-third of the waste (Richardson, 2013). A report by AEA (Atomic Energy Authority) and BRE (Building Research Establishment) showed that the composition of C&D waste by weight is concrete (59%), other inert waste (21%) and metals (10%), followed by timber (7%), plasterboard (1.4%), while insulation and plastics were below 1% of total waste by weight (CRWP, 2009).

Design, or even better at the pre-design stage, is the best place to plan for waste minimization and resource efficiency in the different phases of building procurement and to make it an integral part of the construction process. Providing complete drawings and specification of materials, and planning for waste minimization, not only for the completed building but also for the construction site, will increase the chance of reducing costs of the construction project. Based on Resource Efficiency in Building and Related Industries (REBRI) (2014) studies, designers, architects and engineers can have a significant influence on the efficiency of this process. Using high recycled content materials, such as aluminium joinery, is one example of a strategy for reducing waste with no impact on time and cost (Inglis, 2007). Another strategy would be to agree a waste management plan between contractors and subcontractors that contains the responsibilities, measures to reduce waste, estimations of waste, and alternatives to disposal. (Jaques, 2018). Communicating with waste contractors to find the necessary recycling facilities and giving them a plan for phasing of bins, or asking subcontractors to remove (and recycle) their own waste could be part of a waste management plan. Large developers have another opportunity to think laterally and coordinate a waste minimization plan in such a way as to benefit from recovered materials in other projects. Monitoring waste flows and minimization practices in projects and documenting these, means what is learned can be translated to other projects or can also be taught in workshops (Inglis, 2007). Governments can influence the waste management plans of building projects and promote C&D waste minimisation through guiding contractors as to how to do this (Jin, Li, Zhou, Wanatowski, & Piroozfar, 2017; Wu, Ann, & Shen, 2017). Variations in the mind-set and skills of different stakeholders from long established approaches are also a challenge (Migliore et al., 2019).

Based on a study in the US, most of deconstruction projects are by middle income home owners, who also have the role of consumers for pre-used materials and products. Residential buildings have more potential for reclaiming building materials because of the freedom that the owner has on

decision making. However commercial building projects have less time constraints and there are also more opportunities to gain LEED credits (see section 3.2) when it comes to reusing materials. There is no difference in the completion rate of both residential and non-residential projects when it comes to the reuse of materials (Guy, 2008, 2009). When disposal costs reach a certain threshold and the potential benefits of deconstruction are considered, systematic dismantling of buildings for re-use can become economically feasible solutions (Guy, 2008).

Prefabrication is viewed as an effective measure in construction projects for reducing C&D waste based on opinions given by stakeholders, including contractors, consultants, developers, government departments, and environmental professional associations (Tam, 2008). In Malaysia, stakeholders (government agencies, developers, consultants and contractors) think that selection of materials, modular design, construction techniques, and training the crew are important in reducing C&D waste (Esa, Halog, & Rigamonti, 2017).

2.2.1 Obstacles

The Working Commission of Construction Material Stewardship (W115) of the International Council for Research and Innovation in Building Construction (CIB) published a report based on investigating the barriers against deconstruction and the reuse of building materials. The aim for the project was for the report to be used as a tool for the education of the relevant stakeholders, particularly designers and builders. Different countries contributed to this report and brought examples and case studies from a variety of backgrounds. This report indicated that structural limitations, lack of information about finding other uses for RRBMs, and their economic feasibility were common themes among the different countries (CIB, 2014).

Bohne & Wærner (2014) found that barriers to recycling were different depending on the scale of the project. In smaller projects the main barriers were economics, mindset and knowledge, whereas for larger projects space for on-site for separation of wastes and knowledge are more important. Apart from these major barriers, they also found each material had specific barriers given current technologies (Bohne & Wærner, 2014).

2.2.1.1 *Mindset and knowledge*

One of the obstacles to better waste management is the attitudes of people towards recycling in building construction. This is a human factor and since construction activities are labour intensive, these human factors, or in another words the attitudes of those involved, are significant when it comes to decreasing waste levels in construction (Begum, Siwar, Pereira, & Jaafar, 2009).

A study by Guy (2009) on the main stakeholders (designers, architects, government, and the salvage industry including building firms) showed that for firms that did not reuse materials the main reasons were that clients did not show any interest in these, they could not find sources, and they had problems with constructability and logistics. For those architects who did reuse materials, in order of importance, the main challenges were constructability, time, and work flow. Aesthetics and environmental impact were more important for architects and designers than costs and achieving LEED credits when it came to using reclaimed building materials (Guy, 2009).

Waste has also been thought a low priority for people in the construction industry, with their differing culture, policies and approaches (Richardson, 2013; Teo & Loosemore, 2001). The construction industry is a fragmented market and different types of people with different approaches and purposes are involved. This variety results in a challenging situation when a strategy like waste minimisation needs to be accepted by all but none take responsibility for it (Hicks, Heidrich, McGovern, & Donnelly, 2004; Ofori, 2000; Srivastava, 2007; Walker, Di Sisto, & McBain, 2008).

In Canada, barriers to reusing structural building materials included lack of awareness, unacceptable options to conventional materials (technical and economic), lack of cooperation, and lack of regulations, all suggesting the deconstruction and design process needed to be improved (Earle, Ergun, & Gorgolewski, 2014). Earle et al. (2014) also discussed how, despite the abundant sources of information about reusing materials and deconstruction, industry professionals were unaware of the value and importance of this approach. Besides the common barriers like time, cost, the need to have waste management planning, and the market, they also recognised lack of cooperation between stakeholders as a barrier.

In New Zealand, Storey and Pedersen (2014) believed competitiveness in the construction market did not allow stakeholders to network and communicate so as to have a better understanding of each other's situation, and this was an impediment to waste reduction and the reuse of materials.

The market for second hand, antique building components is growing and the supply does not meet the demand of consumers, but this is different from the market for other high-volume wastes like crushed concrete aggregates. This fashionable, developed world, trend also has an influence on the market demand for pre-used building materials and components. However, the use of these sorts of materials in order to match other materials or have an aged look is not mainstream design (Storey & Pedersen, 2014).

2.2.1.2 Regulations, codes, constructability, and guidance

Chung and Poon (1999) showed that cities with rapid urbanization will face waste management problems which stem from a lack of infrastructure and a code of practice, increasing amounts of non-recyclable materials and increasing waste generation. Lack of motivation is one of the barriers to separating waste, but the lack of a code of practice involving all levels of stakeholders and lack of environmental knowledge amongst government officials are other examples of obstacles in waste reduction. For instance, establishing appropriate guides for operators should enhance the competitiveness of businesses, so local businesses engaged in recycling transactions could work more efficiently, including the management and marketing of collected items and materials (Chung & Poon, 1999).

There are also legislative and marketing challenges when it comes to reducing, reusing, and recycling C&D waste, which in a wider perspective means protecting the environment and saving natural resources (Richardson, 2013). Studies regarding the role of legislation show its importance (Tam, Tam, et al., 2007; Zhou, 2009).

Research in Germany and Singapore found the barriers were difficulty of dismantling, lack of required building codes, lack of economic feasibility, and lack of case studies (Anggadajaja, 2014; Kuehlen, Thompson, & Schultmann, 2014). In both Japan and the Netherlands the major barrier was difficulty in dismantling (Durmisevic & Binnemars, 2014; Nakajima, 2014). In Norway the main barriers were the scale of the project, economics, knowledge, and space on site (Bohne & Wærner, 2014).

In New Zealand, lack of guidelines and strategies to enable local governments and city councils to follow the principles of the Waste Minimisation Act and encourage deconstruction, and the reuse and recycling of building materials and components is a problem. Studies of waste composition and

the situation in the building construction industry are very old (Storey & Pedersen, 2014) and therefore not relevant to current activities. Storey and Pederson (2014) also found that reducing C&D waste was a target for the government but not a priority for action and funding.

Extending the responsibility of producers for the materials and components they make is a possible approach, but one that is not practical for materials with long life spans. It also becomes more complicated for imported materials, and in New Zealand most building materials are imported from countries where regulations, subsidies and the environmental situation could be different (Storey & Pedersen, 2014).

In New Zealand, as in other countries, waste minimisation policies are created by central government but need to be implemented by the local authorities, who may be reluctant or lack the necessary resources. Also, the 2008 Waste Minimisation Act, does not specifically target deconstruction and reducing C&D wastes (Storey & Pedersen, 2014).

2.2.1.3 Cost and time

Ultimately, economic issues always play an important role. Researchers have shown that incentives like subsidies or non-incentives like taxes are as important as policies in enhancing reuse and recycling (Wu et al., 2017; Zhao, Leefink, & Rotter, 2008; Zhao, Leefink, & Rotter, 2010). Tam (2008) showed that the overhead cost of C&D waste minimisation in construction projects was the main difficulty over time, quality, safety, and environmental impact, with the latter being the least important issue.

The Resource Efficiency in Building and Related Industries (REBRI) was a collaborative effort in New Zealand that tried to develop a guideline to reduce construction waste that considered both business and practical issues. REBRI is not active today and the last update of their information was in 2009. Based on REBRI, waste reduction does not just have financial and business benefits, but also has costs (Inglis, 2007).

The real cost of building materials wastage includes the cost of purchasing, transporting to site and landfill, storage at site, landfill disposal and levy, and the potential value of salvage. If clients were informed as to how much of their money goes to landfill, they would probably accept a good waste management plan or the use of RRBMs (Jaques, 2018).

Under the Waste Minimisation Act (2008), the levy in New Zealand is NZ\$10 per tonne for any kind of waste. Although the Green Party has suggested increasing the waste levy to reduce waste dumped at landfills, the National Party believes doing this could increase illegal dumping (RNZ, 2018a). There are two types of landfills that accept C&D waste, C&D landfills and cleanfills (MfE, 2018). However, the waste from buildings is not limited to C&D, since many other building related products find their way to landfill, such as the rejected interior finishes and furniture from the high turnover in office fitouts. In an Australian study by Forsythe and Fard Fini (2018), the materials from 55% of demolished office fitouts went to landfill (Forsythe & Ahmadian Fard Fini, 2018).

The CIB (2014) report indicates that political strategies can create artificial economic incentives, because in remote areas it is more economical to reuse building materials, but there is not enough market demand everywhere. These incentives are usually through landfill taxes and require national and local governments cooperation (CIB, 2014).

In the United States, time and money are the major barriers (Chini & Buck, 2014) to reducing C&D waste. Storey and Pedersen (2014) also found preparing this type of material so it could be used appropriately could take more time. The same authors also believe the construction industry should be ready to take the risk that this approach could be more time consuming on the grounds that doing it will conserve the environment, rather than the hope it will save money, until the market becomes stable as new rules and regulations come into force.

2.3 Building Certification

2.3.1 Building sustainability rating systems

One possible way to encourage the use of RRBMs could be through building certification systems. These are generally set up to demonstrate that a building constructed with certain features is more sustainable than one built more conventionally.

Launched in 1990, BREEAM is the world's first rating system, and covers materials and waste. LEED credits for building are in five categories including materials and resources (Bahho, 2017). The New Zealand Green Building Council rating systems do not rate materials or components but the whole building, and in this process they prefer environmentally friendly materials to conventional ones in the market (NZGBC, 2019). Green Star also has a system for rating dwellings called Homestar. The

latest rating system is the Living Building Challenge. The following summarises how these various rating systems deal with materials.

- BREEAM is one of the world-leading assessment tools for sustainable buildings. The waste category is split into two aspects of “construction waste reduction” and “diversion of resources from landfill” gaining up to two and one point(s) respectively (BREEAM, 2016).
- LEED is a worldwide rating system aiming to encourage high-performance buildings. A building can gain up to eight points under the waste performance category (LEED, 2019b), as follows: “Storage and collection of recyclables” and “C&D waste management planning” are prerequisites of the “material and resources” category. “Building and material reuse” can gain up to 5 points, “Sourcing of raw materials” up to 2 points, and “C&D waste management” up to 2 points through 4 pathways (LEED, 2019a).
- Green Star is New Zealand’s national rating scheme that evaluates the environmental attributes and performance of buildings and was adapted from the Australian Green Star rating system. It is also aligned with BREEAM and LEED. Up to three points are awarded to projects where management practices minimise C&D waste. The technical manual provides more information for contractors and other stakeholders and also a list of common materials that can be reused and recycled (NZGBC, 2017).
- Homestar is a rating system developed by NZGBC in partnership with BRANZ and Beacon Pathway, that rate homes on the scale of one to ten. It considers waste management in the aspects of waste management and reduction. These two aspects together can gain up to 5% of the total points. Full credit can be obtained when the generated waste that goes to landfill is less than 10kg per m² of floor area (Jaques, 2018).
- Living Building Challenge is a system for certifying buildings that operates in twelve countries, including New Zealand, with three types of certification. This certification system “uses the metaphor of a flower because the ideal built environment should function as cleanly and efficiently as a flower”. There are seven Petals and each has a number of imperatives, collectively making twenty imperatives. One of the Petals is Material and one of its imperatives is Net Positive Waste. According to the guideline, each project should have a Materials Conservation Management Plan and at use of least one salvaged material (a material that has been used previously) per 500 square metres of gross building area or be an adaptive reuse of an existing structure (International Living Future Institute, 2020).

2.3.2 Building materials sustainability rating systems and labelling

When building materials become part of measuring sustainability it is suggested they should be presented in terms of the production, performance and reuse/demolition phases (Basu & Bidanda, 2014). The Eco-labelling Index, the global directory of ecolabels, provides a list of 120 ecolabels for building products from around the world (Ecolabel Index, 2019). The Sustainability Business Network in New Zealand records the sustainability labelling systems for products and buildings, as set out below.

- The Environmental choice New Zealand label displays how the manufacturer has reduced the adverse environmental impacts of their production process (Conder, 2008).
- Green build is a database that assesses and records the environmental impacts of building products and gives technical details, and certification information in New Zealand (Conder, 2008).
- Ecospecifier is an Australian-based guide that provides information on environmentally-friendly building products and can be used for products available in New Zealand (Conder, 2008).
- Greenspec is another helpful website for assessing environmentally-friendly building products. Although it is UK-based it can provide relevant information for New Zealand (Conder, 2008).

2.4 Reuse and Recycling of building materials

The general advantages of reuse and recycling have been mentioned earlier in this chapter and have also been reviewed by Jin et al. (2017). They include conserving natural resources by using fewer raw materials and energy, generating fewer greenhouse gas emissions, occupying less space as landfill and reducing the associated health risks, and gaining credits by complying with policies, standards and certification criteria.

2.4.1 Definitions

2.4.1.1 *Reuse*

Although reuse has been a common practice in the past, such as using the timber and stone from destroyed buildings, it is currently both a challenge and a pressing issue (Bahamón, 2010). Although reuse cannot be suitable for every building project, its advantages cannot be ignored. Construction is a major waste-producing industry but there are also many opportunities for reusing materials and components. Removable parts such as partitions, services, fittings, and fixtures are the items with the greatest potential for reuse and, if they cannot be used on site, there is the opportunity for their reuse in another location. Some of the benefits achieved through this approach include reducing the transportation of waste to landfill and new materials to the site, reducing the burden on landfills, reducing the costs of landfill taxes and buying new materials, reducing environmental impacts, and saving natural resources (Richardson, 2013).

Taking advantage of reuse and recycling during the design process is based on multiple factors such as availability, ease of refurbishment, product liability, and environmental benefits and costs (Addis, 2012). Increasing the recycling potential of buildings requires not only increasing the use of recycled materials through wise material choice, but also designing the building for disassembly. However, the importance of maintenance and its consequences during the building's lifetime should be considered when using reclaimed building materials (Thormark, 2006). Reuse or superuse of some materials or by-products can provide a shelter for human habitation with low environmental impact but may be unacceptable to the average western lifestyle (Richardson, 2013).

2.4.1.2 *Superuse*

The idea of reusing emerged in the early 1970s in America, with its initial concept being to reduce environmental impacts. Superuse is preparing waste materials whose initial purpose was different through adaptation for the new task. Utilising used oil drums to make a wall, packaging foil as insulation, and airplane fuselages as buildings are examples of superuse in building construction (Van Hinte, Peeren, & Jongert, 2007). Superuse is more than reuse, as it introduces new aesthetic principles which challenge the mind to see disparate waste materials as normal building materials. Superuse minimises waste without consuming significant energy for its conversion to useful

components, while giving a different architectural role to them based on their building quality aspects. When value is given to wastes, they are no longer wastes (Figure 6).

Figure 6. Wikado playground, 2009. Constructed from five discarded rotor blades that are used to create a maze-like space. Retrieved from <https://www.denisguzzo.com/projects/superuse/>

2.4.1.3 Recycling

The life cycle of building materials should encompass the reuse, recycling, and disposal stages to give a more realistic output. For example, with an embodied energy of 24 MJ/kg, steel will have the same performance after being recycled many times but concrete, with an embodied energy of 1 MJ/kg, can only be turned into aggregate when first recycled. Material quantities and the energy required for recycling should be taken into account when making comparisons of life cycle costs. Steel, aluminium, and copper have a good history of recyclability; U-PVC and some plastics can be turned into new products after recycling; and glass can be used for thermal insulation as glass fibre or as aggregate for concrete (Lyons, 2014).

Generally, recycled content materials are named depending on the stage at which they are extracted from the material production or use processes. A left-over from a manufacturing process which uses primary materials is called a secondary material, waste from a manufacturing process is called a post-industrial by-product or waste, and when it is a waste from the end-of-life of a product,

it is called post-consumer waste. Among these possible sources, it is preferable to use materials that have not yet been processed. When there is a mix of different sources of materials, the percentage of raw or recycled material should be given along with its source (Addis, 2012). The market value of wastes is a benefit which needs to be estimated as it depends on the local market. The externalities of landfill costs include loss of amenity in the vicinity of the landfill, emissions and leachate but the value(s) of the recycled wastes should also be considered (Tim Denne, Irvine, Atreya, & Robinson, 2007).

2.4.2 Reclaimed and recycled content building materials

A cost benefit analysis of recycling by the MfE in New Zealand showed there would be a market for timber and concrete wastes (MfE, 2019). A great amount of C&D waste (850,000 tonnes in 2007) went to cleanfill which meant it is generally free of contaminants and could be recycled. The main categories of cleanfill were timber (38%), and concrete and rubble (25%), followed by smaller quantities of plasterboard, metal, expanded polystyrene, window glass, windows, doors, and fittings (Tim Denne et al., 2007). Based on the Environmental Snapshot in 2010, 2.531 million tonnes of waste went to municipal landfills in New Zealand (MfE, 2011), and the main categories of waste were organic, rubble and timber (MfE, 2009b). Based on a report for the MfE by Tonkin & Taylor (2014), there were 1,047 non-municipal landfill sites in New Zealand and from 2000 to 2013, the two main components of waste in these landfills were cleanfill and C&D waste

Denne et al (2007) stated in their study that there are three sorts of timber in terms of quality; low quality timber can be reused for temporary works like boxing for concreting, high quality timber can be used more permanently and even for structural purposes, especially native hardwoods, and off-cuts can be used for landscaping (Figure 7). Concrete and rubble can be reused as aggregates for roading, pavement, drainage, and fill. However, the viability of this reuse depends on the location in New Zealand. In some areas, such as the Canterbury region, in order to reduce the risk of flooding, use of river gravel is encouraged, so recovering concrete and rubble aggregates is more expensive. Other barriers against recovering timber and concrete are the costs of manual sorting, such as that for separating treated from untreated timber, the costs of processing and chipping, the costs of crushing concrete, and storage space on-site. Overall, Denne et al (2007) state there are positive benefits from recycling concrete and rubble and timber (MfE, 2019).

Figure 7. Wood chips from timber offcuts for use as mulch in landscaping, (2019). Retrieved from <https://mulch4u.com/products/wood-chips>.

Based on studies by BRANZ (Jaques, 2018), the choice of building materials is often based on short-term needs, and these choices may generate a lot of waste which is a long-term concern. Manufacturers and suppliers can help consumers be informed about waste minimisation through actions such as eco-labelling, remanufacturing, standardizing sizes, rethinking packaging, considering durability, reducing maintenance requirements, designing for disassembly, taking back packaging and other wastes, describing what should happen at the end of life, educating tradespeople, and providing a just-in-time delivery (Jaques, 2018)

The market for reclaimed building materials is changing based on the availability of local outlets, demands and salvage characteristics. There are different ways of reusing building materials on site depending on the type of material. For example, bricks with soft lime-based mortar can be cleaned and used again and hardwood timber can be upcycled into furniture (Figure 8). Dealing with hazardous materials like lead-based paints and asbestos should also be in any waste management plan (Jaques, 2018).

Figure 8. Upcycling timber to furniture, Banquet table made from reclaimed Oregon with splayed leg detail, (2019). Retrieved from <https://www.threeofakindfurniture.com.au/timber-dining-tables-sydney>.

In renovation projects, different strategies can be taken into account. For example, reusing sound items by maintaining or refixing them, reclaiming items from other projects, and opting for a timeless style (Jaques, 2018).

Deconstructing buildings with the purpose of reusing some materials and components has challenges because of potentially complex construction systems that may have different components, labour costs, and limited opportunities for reclaimed items to be reused for structural purposes. One way to overcome these hurdles is to design buildings with disassembly techniques for deconstruction (Figure 9). An initial assessment of the situation, including a cost benefit analysis, makes planning for deconstruction easier. There needs to be an inventory of materials, scheduling of sufficient time, and briefing of stakeholders. Good examples of buildings for deconstruction are building with unique timbers, special features, or with high quality reusable items. Consulting with the builder, architect, carpenter, tradespeople, structural engineer, materials specifier, recycling or removal company, and client will lead to problem solving and creating more opportunities for reclaiming building materials (Jaques, 2018).

Figure 9. Arup's Circular Building is an example of design for disassembly with a circular economy approach, (2016). Retrieved from <https://www.architectsjournal.co.uk/opinion/circular-thinking-will-arups-prototype-change-the-way-we-design/10012452.article>.

2.4.3 Reuse and recycling opportunities in New Zealand

Weighing up the different influential factors in the selection of materials is challenging; for example, a material with higher energy consumption in manufacture may be more durable and easily recyclable, and an expensive one may cost less in maintenance or vice versa. For example, the embodied energy (EE) of virgin aluminum is 192 MJ/kg, while that of recycled aluminum is 9 MJ/kg in New Zealand (BRANZ, 2013). Based on a report by the European Aluminium Association, the embodied energy of primary aluminium is 157 MJ/kg, and that of recycled aluminum is 7.85 MJ/kg in Europe (Stacey, 2017). Aluminium can be recycled forever with the input of energy, and the low embodied energy of recycled compared to virgin aluminium can influence the embodied energy of the whole building. This difference in the embodied energy of aluminium shows that the energy used for producing materials is very important, although designers should also consider whole lifecycle costs, as well as initial EE, maintenance and replacement EE, and demolition and disposal. Since one of the definitions of building sustainability is replacing a process with one involving less depletion of resources, it is good to use recycled materials wherever possible. Table 2 shows the possibilities for using construction wastes. Also, waste minimization in the building construction process results in saving money, reducing resource use, and ultimately reducing environmental impact, so that it could be an immediate and effective approach towards sustainability (Conder, 2008).

Table 2. Material data sheet adapted from (Conder, 2008)

Material	Reuse	Recycling	Waste disposal
Glass	Limited	Glass wool insulation, new glass and aggregate	Landfill
Timber	Some can be reused	Some can be recycled	Untreated is biodegradable, CCA-treated needs special disposal
Aluminium	Some can be reused	Except anodized and some alloys	Landfill
Steel	Some can be reused	Except some alloys	Slowly degrades
uPVC	Can be reused	Can be recycled	Slowly degrades, burns with toxic gasses
Polystyrene	Some can be reused	Can be recycled	Slowly degrades?
Concrete	Precast	Aggregate	Cleanfill
Cement-based Plaster	Cannot be reused	Fill material	Cleanfill
Concrete masonry units	Not yet	Aggregate	Cleanfill
Fibre-cement	Cannot be reused	Fill material	Landfill
Paint	Cannot be reused	Cans	Hazardous
Clay brick	Some can be reused	Hardfill	Landfill
Concrete roof tile	Some can be reused	Fill material	Landfill
Clay roof tile	Some can be reused	Fill material	Landfill
Earth	Can be reused (cement stabilised earth blocks)	Can be recycled if not mixed with cement	Cleanfill
Straw bale	Not yet	Not yet	Biodegradable
Stone	Some can be reused	Aggregate, decorative chip	Cleanfill
Glass wool	Some can be reused	Not yet	Does not decompose, non-toxic
Sheep's wool	Some can be reused	Can be recycled	Slowly degrades
Polyester	Some can be reused	Can be recycled	Does not decompose, non-toxic
Sheep's Wool/polyester blend	Some can be reused	Not yet	Landfill
Mineral wool	Blown-in cannot be reused	Not yet	Slowly degrades
Cellulose fibre	Cannot be reused	Not yet	Landfill
Gypsum plasterboard	Little	Can be recycled	Cleanfill
Wood composites	Some can be reused	Not yet	Landfill
Cork flooring	Difficult	If a facility exists	Slowly degrades
Vinyl flooring	Cannot be reused	Some can be recycled	Slowly degrades, burns with toxic gasses
Linoleum	Cannot be reused	Cannot be recycled	Biodegradable
Rubber flooring	Cannot be reused	Some can be recycled	Landfill
Wool carpet	Some can be reused	If a facility exists	Landfill
Synthetic carpet	Some can be reused	Can be recycled	Slowly degrades
Ceramic tiles	Cannot be reused	Fill material	Landfill

Radiata pine is a common timber in New Zealand that needs treatment if it is to be used in a damp area. Untreated and low level treated timber is biodegradable while CCA-treated is difficult to dispose of because it produces hazardous leachates. However, CCA-treated timber is more durable and can be exposed to harsh weathering. Aluminium is produced in New Zealand with hydro power but the primary material (bauxite) is imported from Australia. Pure and painted aluminium can be recycled, but anodised aluminium and some alloys cannot be recycled with current technologies. Steel in New Zealand has the highest rate of recycling and excess steel scrap especially stainless steel is exported. However, some alloys and compounds are difficult to recycle. Un-plasticised PVC

(uPVC) is mainly used in New Zealand and can be recycled. It also decomposes very slowly without environmental risks, but when burned it produces toxic gasses. Portland cement produced in New Zealand has a relatively low environmental impact than cements from other countries because of controls over plant emissions and water use. Typically, concrete can be reused as the aggregate in new concrete, or for other uses like paving and roading. It can be disposed of in cleanfills but is heavy to transport. Fibre cement sheets are produced in New Zealand using cellulose fibres sourced from local radiata pine. Bricks are not used much in New Zealand and are commonly produced from local clay or imported from Australia. Bricks with soft mortar can be reused again, and crushed bricks can be recycled for basecourse or hardfill purposes. They can be disposed of to cleanfill but are heavy to transport. Concrete roof tiles can be reused again as long as they have acceptable integrity, or crushed as fill. Similarly, clay roof tiles can be reused but not recycled, though if they are damaged they can be crushed as fill. Earth building materials can be recycled, although if the earth is mixed with cement, as is common, this may be more problematic. Stone is not used for structural purposes in New Zealand. Cork is a renewable resource, but is imported. Floorings such as vinyl, and rubber, are usually difficult to reuse due to the difficulty of lifting them without damage. Carpets in New Zealand are mainly wool or synthetic fibres, but there are natural plant fibre carpets of seagrass, jute, hemp, sisal and coir. New Zealand-made wool carpets are sourced from natural strong and uniform fibre and made by machine. Wool carpets can be recycled if the necessary facilities exist (Conder, 2008; Jaques, 2018).

2.4.4 Case study of agricultural by-products

To investigate the potential of wastes further, section 4.4 is a case study of agricultural wastes and how effective these might be as building materials.

2.4.4.1 Introduction

The increase in the population has not only resulted in more buildings but also in increased demand for agricultural products. So, reducing the environmental impacts of agricultural activities is another issue that can be partly controlled by reusing its by-products. These could be a reliable resource

considering the amount grown. This section, therefore, looks at the use of agricultural wastes for making building materials and what might be achieved.

Major driving forces behind the idea of using agricultural crop residues as natural fibres are depletion of natural resources, new regulations on using synthetic fibres, growing environmental awareness of the need to reduce environmental impacts, and potential economic benefits.

Apart from policies and economic issues having influence on reuse and recycling and consequently buying recycled content building materials, it is important to study the technical aspects of the recycled content materials, including quality issues. Agricultural by-products as a primary resource for production of building materials will also need future testing before these can be relied on, but this is outside the scope of this review.

Reusing waste and the by-products of agriculture, as with other industries, produces opportunities for developing a circular economy. One way of reusing this waste is to produce bio-based materials, and one type of such material is building insulation. The interest in finding alternatives is growing in the construction sector which is a resource-intensive industry. Reusing these natural renewable resources in a circular economy approach needs assessment of their environmental, economic, and socio-cultural aspects hand in hand with their technical viability (Balador, Isaacs, Gjerde, & Whitburn, 2017). This section intends is only concerned with the latter.

A number of studies have focused on finding substitutes for petrochemicals for manufacturing building insulation. Some have identified insulation materials that have lower environmental costs, for example those made of natural or recycled materials (Balador, Gjerde, Isaacs, & Imani, 2018). Manufacturing building insulation from agricultural by-products is one such approach. However, this is in the early stages of development and there is a long way before they could be on the market.

Alongside identifying matters that require additional research to enhance technical reliability, this section explores issues that can improve market viability and help make natural and recycled materials more attractive alternatives. Although there are common themes regarding the use of these materials, earlier studies (Balador, Gjerde, Isaacs, & Imani, 2018) have revealed that each of these agricultural wastes can be used for specific purposes and each has some advantages and some drawbacks. From another perspective, it is important to compare the performance of these new materials with that of more conventional options. This is one of the first steps needed to modify the attitude of the industry toward them.

At first sight, agricultural wastes do not seem a likely candidate for building construction; however, a review of some traditional techniques finds they had typical uses in construction. For example, use of reeds in Iraq or Egypt, palm or banana leaves in Africa, and bamboo in Eastern Asian countries have a long history. These kinds of natural materials with all of their benefits have probably fallen out of favour because of the boom in artificial fibres and the fact people no longer want to live in buildings made from natural materials, at least in the developed world (Ryan, 2011).

Natural fibres are among the materials that have a positive environmental impact, if they can be grown organically and processed using a sustainable manufacturing process for their conversion into a high performance and energy efficient product. They are also biodegradable at the end of their lifecycle. Natural fibres, in this study, are the non-edible plant parts that are left in the field after harvest and also the by-products and leftovers of manufacturers who use these fibres.

Although there are examples of bio-based solutions in the market such as straw bale, and others are trying to compete, such as coconut-wood composite, cork and almond polymer composite, algae and fungus-based textiles, bark cloth, and maize cob board, there is still a long way to go until they become conventional items in the list of building materials (Balador, Gjerde, Isaacs, & Imani, 2018).

After a review of research into agricultural wastes and natural fibres (Balador, Gjerde, Isaacs, & Imani, 2018) a number of similar characteristics were revealed. A summary of mostly common themes is presented in Table 3. The inherent properties of natural fibres make them good options for thermal and acoustical insulators. However, these inherent properties are not always helpful, since many natural fibres have a non-homogeneous structure, and there are still no reliable theoretical models to explain their behaviour. Thus a wide range of tests with different configurations and binders should be undertaken to identify reliable combinations (Berardi & Iannace, 2015). This means the manufacturing process after such investigations is a defining factor which affects the characteristics of insulation materials. Each type of agricultural product can be used for different purposes according to their specific characteristics. Climate and geographical situation are important because using local agricultural waste-based materials has many benefits, such as the need for less transportation.

Although more studies are required to support the use of natural fibres from every aspect, one of the first steps is comparing anticipated results with similar conventional alternatives in the market. Reviewing the literature indicates that environmental impacts and economic feasibility are two steps that should not be neglected (Schmidt, Jensen, Clausen, Kamstrup, & Postlethwaite, 2004).

Positive impacts on human health and psyche are two advantages of natural materials worth pursuing since they are mentioned in studies but have not been studied completely (Asdrubali, 2011; Joshi, Drzal, Mohanty, & Arora, 2004). However, some issues such as resistance against fire and degradation due to moisture, bacteria, mildew and fungi that affects the long-term performance are potential problems (Korjenic, Petránek, Zach, & Hroudová, 2011).

Table 3. Advantages and disadvantages of agricultural by-products as insulation (Balador, Gjerde, Isaacs, & Whitburn, 2017)

Advantages	Disadvantages
Low thermal conductivity	Non-load bearing
Self-binding	Thicker
Fast renewal	Treatment
Abundant	Non-homogenous
Natural	Variation
High specific heat	Unsuccessful theoretical models
High damping of vibration	Non-fire resistant
Bio degradable	Hazardous additives
Cost effective	Contaminants
Lower environmental impacts	Influenced by weather
Energy efficient	Lower durability
Fewer emissions	
Renewable resources	
No skin irritation	
Non-toxic	

2.4.4.2 Estimation of potential

Each region has specific agricultural products according to the climate and the geographical situation. Hence, feasibility studies of insulation from agricultural wastes need to be carried out locally and involve discussion about all critical issues. These would include consideration of whether agricultural residues may have value as feed and soil enrichers, and that diverting them to become building materials may deprive the agriculture industry of important resources. Annual crop yields vary year to year depending on climate and precipitation patterns, soil properties, plant varieties, and farming techniques. Consequently, agricultural crop residues are related to plant variety, crop yield, harvesting techniques and the cutting height. Removing these residues could influence the fertility of the land. Care should be taken when estimating the potential of agricultural residues, since there is a significant annual variation in the quantity of agricultural crops (Table 4) (Scarlat, Martinov, & Dallemand, 2010).

Removing residues from land can have other consequences as well because they often have a role in protecting the soil from erosion, maintaining or increasing soil organic matter, maintaining mineral nutrients in the soil and improving water retention. Removing a part of these residues from

the land can be compensated for by conservation tillage, adequate crop rotation, and the addition of manure and fertilisers (Lal, 2005; Scarlat et al., 2010). Lal (2005) and Scarlat et al (2010) have provided guides for residue-to-crop production ratios and sustainable removal rate in the US and EU respectively.

Agricultural crop residues have different competitive uses such as in animal husbandry or horticulture/mushroom production, or even in bioenergy plants. Therefore, evaluating them in terms of their benefits as a primary material for the building insulation industry compared to other uses is essential. Using agricultural residues for building insulation is not only a good opportunity but also a strong competitor for these other uses, and this needs to be considered.

Table 4. Factors when estimating agricultural residues (Scarlat et al., 2010)

Factors taken into account for estimating agricultural residues	<ul style="list-style-type: none"> •types of crops and area of crop production; •yields of crops (wheat, rye, barley, oats, maize, rice, rapeseed and sunflower); •crop residue-to-yield ratios, depending on the crop yields; •crop residue removal rate according to the environmental constraints and the requirements for soil conservation; •competitive use of crop residues for animal bedding and mushroom production
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Apart from the sustainable yield, other factors that need to be considered are resources (quantity, multi-annual yield variation), logistics (storage, security of supply, harvesting period, and transportation distance), technological issues (available processing technologies), economics (costs of resources), and social issues (perception and attitude of farmers) (Scarlat et al., 2010).

2.4.4.3 The agricultural situation in New Zealand

The agricultural industry in New Zealand is second in operating profit and income only to the real estate industry (Statistics New Zealand, 2015), with over 14 million hectares of land used in the production of agricultural products (Statistics New Zealand, 2012a). New Zealand has an abundance of maize (corn), flax, wheat and nut wastes that have the potential to be used in building insulation production (Statistics New Zealand, 2012b, 2012c).

In New Zealand, wheat, barley, oats and maize are the main grain and seed crops (Statistics New Zealand, 2012c). According to reports on grain and seed production by Statistics New Zealand (2002)

the area of arable land yielding the highest production of wheat, barley and oats is in the Canterbury area. Southland, Otago and the Manawatu-Wanganui area have similarly high production. For maize production the North Island is the primary location with hotspots in the Waikato, Gisborne, Manawatu-Wanganui, Bay of Plenty and Hawkes Bay areas. After the growth and extraction of these grains and seeds they enter the processing industry, with most becoming flour, malt and animal feed (Zydenbos, 2008). Straw as a by-product of the production of these grains can have different uses including: returning to the soil for nutrients, burning and returning the ash to the soil, and selling as straw bale for purposes such as mushroom production, bedding for animals, and garden mulch (Zydenbos, 2008). The supply of potential waste products from agriculture varies year by year, being affected by the weather, economics, and competition. The average New Zealand arable farm of 393.6ha produces 11.7 tonnes of waste per year of which 7.4 tonnes are non-natural waste, 1.1 tons are domestic wastes, and 3.2 tonnes are organic materials (Tonkin & Taylor Ltd, 2014a, p. 33).

Flax (*phormium tenax*) can be found abundantly in New Zealand and Māori have developed many uses for it, including weaving the fibre. This is a different plant from linen flax (*Linum usitatissimum*) or linseed that grows in colder areas. Linseed is grown in New Zealand for oil and for baking purposes (Townshend & Boleyn, 2008). Flax was the primary material for the clothes of the Maori people of New Zealand before the arrival of European settlers. It was also woven into baskets and discarded pieces of *phormium tenax* were traditionally put under the plant to convert them into compost (Brown, 2011). Growth in manufacturing saved the flax industry in 1930 for a further 50 years with the support of government, by using flax fibre for woolpacks (a coarse bagging material used for covering bales of wool), and also as underfelt, floor coverings, upholstery materials, and binder twine. However, in 1985 the last manufacturer was closed because of the introduction of synthetic fibres and lack of government support (Matheson, 2000). Growing trends towards renewable resources have made the flax industry strong again. Researchers are currently exploring new uses for flax and its left overs by improving the quality of its products, combining it with other materials, and investigating its environmental and commercial benefits. This has widen opportunities for its use in new industries such as building materials, furniture and packaging, that is showing a promising future (Swarbrick, 2007).

Industrial hemp has been grown in New Zealand since 2003, but is not yet intensively cultivated. This plant grows to a height of between 1 and 5 metres in 3 months, at a density of 150 plants per square metre (Berger, 1969). Industrial hemp has a wide range of uses in the health and therapeutic

markets as well as in many other areas. The high-quality fibre is taken from its stalk and used in manufacturing cordage, textile, paper and fibreboard. The value of these natural bast fibres are defined in terms of length and content of lignin (Aghedo, 2007). The deep roots of the plant prevent erosion, cleanse the ground, the plant can control insects in orchards, provide a disease break, and aerate the soil. It needs less labour and energy to grow because it does not need husbandry until harvesting, and it extracts nutrients from the ground much faster than other crops. The high yields of hemp provide a good alternative to traditional building materials such as wood in many applications (NZHIA, 2015). Plant fibre extraction requires highly mechanised processes with expensive machinery making the cost of developing composite hemp materials quite high (Hobson, Hepworth, & Bruce, 2001). Simplifying the processes and lowering the cost of the production of these materials is a concern (George, Sreekala, & Thomas, 2001; Saheb & Jog, 1999). The inner woody core of stalk was previously considered waste. This forms 70-80% of the stalk, but has the potential to be used as tissue, newsprint pulp, rayon, biomass fuel, cellophane, food additives, and industrial fabrication materials. It can also be mixed with lime and used in the construction industry as moulded interior and exterior walls (Merfield, 1999). Generally, since 2002 the utilization of this fibre crop has increased in the food, textiles, oil and construction markets (NZHIA, 2015).

Studying the history of using agricultural by-products and their agricultural situation will be helpful as a means of clarifying their potential in future studies. The following sections look at the performance of a selection of natural fibres that have been studied in more detail.

2.4.4.4 Characteristics

Natural fibres, plant fibres, or vegetable fibres which are made of cellulose are found in cultivated crops either in seeds or stems (bast). This section reviews the current research on unconventional bio-based insulation materials under four behaviour categories: thermal; acoustical; environmental; and mechanical.

2.4.4.4.1 Thermal

The following section reviews the thermal characteristics of different agro-waste materials, and the most common ones are summarised in Figure 10 and Table 5. The very good thermal performance of flax, fique, hemp, pineapple, coconut, cattail, bagasse, and rice suggests that additional research

into other behaviours would be beneficial. Of these flax (linseed) and hemp are already grown in New Zealand. The thermal conductivity of insulations should be less than 0.07 W/m K to be considered as an insulator (Asdrubali, D'Alessandro, & Schiavoni, 2015). For comparison, the thermal conductivity of glass fibre insulation is 0.023 and 0.040W/m·K, showing the potential for agricultural wastes to be used as insulation in buildings.

Figure 10. Thermal conductivity of some popular agro-waste products (Balador, Gjerde, Isaacs, & Imani, 2018)

Table 5. Thermal conductivity of some popular agro-waste products (Balador, Gjerde, Isaacs, & Imani, 2018)

Product	Conductivity W/m ² K	References
Corn	0.101 - 0.139	(Lertsutthiwong, Khunthon, Siralertmukul, Noomun, & Chandkrachang, 2008; Paiva et al., 2012; Pinto et al., 2012; Pinto et al., 2011)
Durian	0.054 - 0.1854	(Khedari, Charoenvai, & Hirunlabh, 2003)
Coconut pith	0.0416 - 0.086	(Manohar, 2012; Sampathrajan, Vijayaraghavan, & Swaminathan, 1992)
Figue	0.04 - 0.08	(Navacerrada, Díaz, & Fernández, 2014)
Flax	0.033 - 0.09	(Hajj et al., 2011; Korjenic et al., 2011; Kymäläinen & Sjöberg, 2008)
Hemp	0.0393 - 0.123	(Benfratello et al., 2013; Korjenic et al., 2011; Kymäläinen & Sjöberg, 2008; Stevulova, Cigasova, Sicakova, & Junak, 2013)
Sunflower	0.0656 - 0.077	(Evon, Vandenbossche, Pontalier, & Rigal, 2014; Mati-Baouche, de Baynast, Michaud, Dupont, & Leclaire, 2016)
Rice	0.049 - 0.063	(Liu et al., 2012; Sampathrajan et al., 1992; Yarbrough, Wilkes, Olivier, Graves, & Vohra, 2005)
Bagasse	0.046 - 0.068	(Manohar, 2012; Panyakaew & Fotios, 2011)
Cattail	0.0438 - 0.0606	(Luamkanchanaphan, Chotikaprakhan, & Jarusombati, 2012)
Pineapple	0.035 - 0.057	(Kumfu & Jintakosol, 2012; Tangjuank, 2011)

2.4.4.4.2 Acoustic

Earlier studies by Chabriac et al. (2016), Berardi & Iannace (2015) and Oldham et al. (2011) for instances have focused more on the sound absorption coefficient (Figure 11, Table 6). The sound absorption coefficient measures the sound absorption of a material and is the ratio of the absorbed energy to the incident energy of sound at a particular frequency, and the larger the number the better the sound absorption.

Figure 11. Sound absorption coefficients of some agro-waste products (frequencies are given in Table 6 for each material, the given coefficients in the graph are the highest measured coefficients)

Table 6. Sound absorption coefficient of some agro-waste products

Product	Sound absorption coefficient	Description (with different porosities)	References
Flax	0.5-0.85, 0.99	5 cm, 100-4000 Hz, 5.6 cm, 800 Hz	(Chabriac, Gourdon, Gle, Fabbri, & Lenormand, 2016; Hajj et al., 2011)
Hemp	0.25, 0.1-0.85 0.95	3 cm, 125-4000 Hz, 7 cm, 125-4000 Hz, 5.6 cm, 800 Hz	(Berardi & Iannace, 2015; Chabriac et al., 2016; Oldham, Egan, & Cookson, 2011)
Reed	0.45, 0.6, 0.1-0.85, 0.1-0.95	4 cm, 125-2000 Hz, 8 cm, 125-2000 Hz, 4 cm, 200-2000 Hz, 5 cm, 200-2000 Hz,	(Berardi & Iannace, 2015; Iannace, Maffei, & Trematerra, 2012; Oldham et al., 2011)
Bagasse	0.15 - 0.9	1.2 cm, 250-2000Hz	(Doost-hoseini, Taghiyari, & Elyasi, 2014)
Sunflower	0.86	5.6 cm, 800 Hz	(Chabriac et al., 2016)
Rice	0.15, 0.7-0.97, 0.54	0.6 cm, 6000 Hz, 4.5 cm, 500-7000 Hz, 2.5 cm, 125-2000 Hz	(Jayamani, Hamdan, Rahman, & Bakri, 2015; Liu et al., 2012; Sampathrajan, Vijayaraghavan, & Swaminathan, 1991)
Cork	0.3	3 cm, 125-2000 Hz	(Berardi & Iannace, 2015)
Coconut	0.1-0.79, 0.5	5 cm, 125-2000 Hz, 2.5 cm, 125-2000 Hz	(Berardi & Iannace, 2015; Sampathrajan et al., 1991)
Palm	0.38	0.8 cm 3150 Hz	(C. Chen, Zhang, Sun, Wang, & Wang, 2016)

The studies have shown that flax, sunflower, hemp and rice are among materials that hold promise as acoustic insulators, largely because of their good sound absorption coefficients (Table 6). Compared to one of the most commonly used sound absorbers such as fiberglass, a sound absorption coefficient in the range of 0.8-1 can be considered to be a good absorber.

2.4.4.4.3 Environmental impacts

High quality products can be made from plant fibres; however, from the first step, farming, through transportation and manufacturing each step will affect whether the final product is environmentally friendly. Considering every step of the life of these materials, they usually have a low environmental impact comparing to conventional alternatives in the market (Thompson & Thompson, 2013).

The environmental impacts of insulation materials are evaluated through Life Cycle Assessments (LCA) that include the entire life of the materials, the energy it takes to make them and the energy they will save over the life of the building. The aim is to deepen the knowledge of energy and environmental specifications in designing buildings.

Comprehensive environmental analysis has been undertaken for flax and cork in comparison with other commercialized building insulations (Asdrubali, 2009; Asdrubali, Schiavoni, & Horoshenkov, 2012; Lazzarin & Busato, 2008; Schiavoni, D'Alessandro, Bianchi, & Asdrubali, 2016). Looking closely at the life-cycle costs and benefits of building products, such as insulation, is essential if the building industry is to reduce its environmental impact (González-García, Hospido, Feijoo, & Moreira, 2010; Ip & Miller, 2012; H. M. G. Van der Werf & Turunen, 2008). Natural fibres lower environmental impacts through their production phase, but they can have more benefits when it comes to energy efficiency and fewer emissions in the use phase (Joshi et al., 2004). However, adding flame-retardants to flax insulation makes it hazardous for the environment (Schmidt et al., 2004).

Not all LCA studies involve the whole life cycle but they are still useful. Table 7 shows that studies on some popular agro-waste materials deal with the life cycle from cradle to gate, while others only look at specific stages.

Table 7. Environmental assessments of some agro-waste products, the grey cells show that there are studies in that category (Balador, Gjerde, Isaacs, & Imani, 2018)

Materials	Cradle to gate	Other industries	Specific stages
Flax			
Hemp			
Reed			
Palm			
cork			

For example, some studies focus on the field production of hemp (H. M. Van der Werf, 2004), while others include other stages such as insulating performance and energy savings (Zampori, Dotelli, & Vernelli, 2013). Based on the results of many studies, eliminating artificial binders or using natural binders such as lime which has fewer impacts (Benfratello et al., 2013), is a very important factor in lowering environmental burdens (Schiavoni et al., 2016). There are inventories for palm in other industries such as industries for producing fuel, fiber and fertilizer which can help life cycle analysis of it as a building insulation material (Chiew & Shimada, 2013).

2.4.4.4.4 Mechanical and physical properties

This section provides a summary of all other characteristics that insulation materials should have other than their thermal and acoustical performance, such as structural performance, fire resistance, and vapour permeability. As there is a wide range of these parameters, only research related to materials mentioned in previous sections is presented (Table 8).

Agricultural crop residues in this study are non-edible plant parts that are left in the field after harvest and also the by-products and leftovers of manufacturers who use these fibres. However, resource availability, logistics, technical viability, environmental impacts, infrastructural requirements, and other potential benefits should be studied before such products can come to market.

Table 8. Physical and mechanical properties of some popular agro-waste products, the grey cells show that there are studies in that category (Balador, Gjerde, Isaacs, & Imani, 2018)

Product	Flexibility and strength	Fire resistance	Water or vapor absorption and permeability	Microbiological resistance	References
Bamboo					(Yang, Fei, Wu, Peng, & Yu, 2014)
Corn					(Lertsutthiwong et al., 2008; Pinto et al., 2012; Sampathrajan et al., 1992; D. Wang & Sun, 2002)
Durian					(Khedari et al., 2003; Sampathrajan et al., 1992)
Coconut					(Khedari et al., 2003)
Fique					(Navacerrada et al., 2014)
Flax					(Buksnowitz, Adusumalli, Pahler, Sixta, & Gindl, 2010; Hajj et al., 2011; Korjenic et al., 2011; Kymäläinen & Sjöberg, 2008; Segovia, Sauget, Besserer, Kueny, & Pizzi, 2016)
Hemp					(Chabriac et al., 2016; Le et al., 2014; Stevulova et al., 2013)
Rice					(Liu et al., 2012; Mgbemene et al., 2014; Sampathrajan et al., 1992)
Groundnut					(Mgbemene et al., 2014; Sampathrajan et al., 1992)
Cattail					(Luamkanchanaphan et al., 2012)
Pineapple					(Tanguank, 2011)

2.4.4.5 Conclusions and Further Outlook

This part of chapter 2 has discussed the technical information needed to be able to assess the potential for agricultural crop residues to be utilised in the manufacture of different building insulation materials. The discussion has touched on the potential for transitioning to a more sustainable way of producing materials used to insulate buildings, regarding the technical and environmental performances of different agricultural by-products that could be turned into insulation. Globally, construction is one of the largest industries and so changes made to enhance its performance can translate into significant benefits for the wider society.

Following an extensive review of technical studies, the wealth of information available for some of the products in the areas of thermal and acoustical behaviour has been noted. The same cannot be said for the technical characteristics of all agricultural by-products having the potential to be utilised for building insulation. Some 27 agro-waste products were considered in this section, and only five (corn, coconut, flax, hemp, and jute) were found to have been studied across all four categories.

The reason for this may have to do with their availability in different climates. In New Zealand, only flax and hemp could be considered for conversion into natural insulation products. While materials made from these products will have low thermal conductivity because of their porous and foam like structure, they could also have a high sound absorbency provided that they have the other required properties. The absence of such information is sure to limit their uptake by suppliers, specifiers, and consumers.

There are only a small number of complete life cycle environmental assessments of different agricultural waste products as building materials. The focus of mechanical and physical tests is on flexibility and strength and water or vapour absorption and permeability; however, these results are not sufficient to prove the mechanical and physical viability of these materials.

Currently, extensive commercial networks drive the supply and consumption of conventional synthetic insulation materials derived from petrochemicals. It is therefore important to promote a powerful commercial network for ecological insulation, capable of competing in the same conditions with traditional insulation materials.

While a range of potential benefits have been discussed, it is likely that there are more that could also be considered when evaluating agricultural by-products for recycling. These include health benefits, natural degradation, and transportation requirements. It could also be useful to understand how new tools such as GIS mapping could be utilised to help ensure consistent supplies of crop residues. These matters will be the subject of future research. There is a huge capacity and latent qualities for turning these residues and developing them into something valuable in the future.

2.5 Summary

There is a growing need for treating waste as a valuable resource, not only in New Zealand but also around the world. Since C&D waste form a significant proportion of total waste, more effort should be directed toward reusing and recycling it. Part One of the literature review found that this could be encouraged with government support, in terms of passing the required regulations, and developing codes of practice, guidelines, economic incentives, and funding for research. Such approaches are essential if we are to move toward a circular economy.

The literature revealed databases of waste composition and economic feasibility studies should form part of the initial studies as groundwork for creating regulations and guidelines. Educating all stakeholders in the construction industry, including lay people as clients and users, is also essential. Providing clear, transparent and comprehensive information on deconstruction, reuse and recycling options, materials (ecolabels), and regulations is also a requirement for this transition.

According to international literature, many building materials and components have considerable environmental impacts that can be a critical problem for large cities. One of the approaches to reduce C&D waste is the use of RRBMs. A good product design based on deconstruction technologies and with the necessary infrastructure, would allow for reuse, repair, and remanufacture, which would close the resource flow loop, and thus align with SDG indicators. Apart from providing the infrastructure and other pre-requisites and support for using RRBMs, the pre-design and design stage is the best place to have a plan for using them in construction.

The variety of mind-sets, skill, and knowledge of different stakeholders involved in construction remains a challenge, and something that could be further studied. Reviewing the literature on the barriers showed that there are also contextual barriers including economic issues, regulations, and constructability that can stop stakeholders using RRBMs, even those who are motivated. Also, literature on the barriers to deconstruction and use of RRBMs indicated that they can be categorised into three categories, namely “mind-set, knowledge and cooperation of stakeholders”, “cost and time” and “regulations, codes of practice, guides, and constructability”.

Part One of the literature review also suggested one way to encourage and credit waste management planning, deconstruction, and use of RRBMs is through building sustainability rating systems. Although the main rating systems used in New Zealand (Greenstar, Homestar, LEED, BREEAM and Living Building Challenge) all mention materials, none are focussed on these as a core part of construction.

According to the literature, reuse, superuse and recycling are three ways of reusing building materials and components. Removable parts have great potential and there are always opportunities to use pre-used building materials in other construction projects if they are not needed on-site. Superusing the waste of other industries is another option, such as using bottles in walls to let in light. This is also true for recycling materials, as pre-used building materials can be recycled to new ones or a new product with another purpose. Similarly, the wastes and by-products of other industries, such as agricultural by-products, can become a new building material. Consider

for example a sound absorbing panel made from compressed straw. In New Zealand, flax and hemp could also be the source of natural fibre for building material production. The potential is there but the barriers all involve the attitudes of people to RRBMs. Chapter 3, which forms Part Two of the literature review, discusses how these attitudes might be examined and understood and a first step in changing them towards more use of RRBMs.

3 Literature review_ Part Two: Behaviour

3.1 Pro-environmental Behaviour

3.1.1 Influential factors on green purchase behaviour

Based on the definition by Roberts and Bacon (1997), ecologically conscious consumption behaviour is purchasing products that have less negative environmental impacts than purchasing conventional materials.

Increasing environmental concerns have made those involved in marketing interested in finding information on environmentally responsible behaviours in order to stay in the market. Environmental attitudes have a direct, positive influence on people's preferences for green products, and indirectly on their purchase and recycling behaviours. For those who are already concerned about the environment, it is easier to encourage them to perform environmentally by increasing their environmental knowledge (Y.-K. Lee, Choi, Kim, Ahn, & Katz-Gerro, 2012).

Kumar and Ghodeswar (2015) also identified social appeal as an influential factor in the purchase of green products, as well as for feelings of being responsible for saving the environment and for the image of environmental friendliness of companies. Their research suggests that personal relevance, and environmental and social importance are significant in green purchase and recycling behaviours. One of the findings of his study, which is consistent with other similar studies (Bendell & Kleanthous, 2008) is that mere environmental concern does not necessarily lead to environmental behaviour. In light of this, producers should not only adopt green production methods, but also pay attention to the functional, emotional and experiential needs of society. Manufacturers could also present information about their environmental performance that aligns with people's desirable social image and their life style (P. Kumar & Ghodeswar, 2015). Self-identification is one of the most important predictors of green purchase behaviour, although past experience and social influence are also important (Khare, 2015).

A study by Biswas and Roy (2015) has shown that "knowledge value", including giving environmental information on products and eco-labelling, has a strong relationship with "consumption value", and consequently a positive influence on sustainable consumption behaviour by increasing environmental awareness, especially when it comes to preferences for green purchases. Along with these educational drivers, economic incentives such as discounts and subsidies could be considered,

as this will encourage consumers, even the non-green segment. Coherent policies across different organisations will boost the effectiveness of strategies such as recycling, remanufacturing and extending periods of consumption, and this will tilt the preference towards green consumption.

A study by Dursun et al. (2016) revealed that the potentially negative economic aspect did not significantly affect green buying behaviour but that positive influences on personal health and the environment did influence people. On the other hand, for simple or non-green buying behaviour, economic issues were significant. However, the goal of saving money encourages people to engage in pro-environmental behaviours such as repairing, reusing and recycling. Recycling has some immediate infrastructural costs that can be a barrier (55% of the reasons behind not recycling are lack of infrastructure for processing and recovering waste (Dursun et al., 2016)) but it also has long-term benefits that may be hidden from those who are not in the green segment of society. However, green buying may increase recycling indirectly, because most of the green products are recyclable or recycled. Environmental concern in the same study did not show a significant influence on pro-environmental behaviour and particularly on recycling behaviour. In other words, self-caring motivation such as health is a stronger influence on green buying and recycling than concerns about the environment (Dursun, Kabadayi, Koksall, & Tuger, 2016). Earlier research (Freeman, 1990; Ottman, 1998) showed that price, quality and convenience were the most important factors influencing buying behaviour, which in some aspects is consistent with the study of Dursun et al. (2016).

Conversely, in her thesis Grant (2011) concluded that knowledge about the environment is positively related to pro-environmental behaviours, but this only holds true if the behaviour is not difficult to perform in terms of money and time. Earlier Chung and Poon (1999) found that people with a lower level of environmental knowledge had less belief they can avoid producing waste.

Attitudes toward the use of green products are positively affected by the social and environmental image of the company producing them (Grimmer & Bingham, 2013; Sonnenberg, Erasmus, & Donoghue, 2011), good feelings (self-satisfaction in doing a positive environmental behaviour) (Tim Denne et al., 2007), and transparency of information provided by manufacturers (Britzelmaier & Burger, 2012; Cheng, Ioannou, & Serafeim, 2014; Hart, 1995; Lemke & Luzio, 2014). Attitudes are negatively influenced by gaps between claims made by companies and actual performance, difficult access to information (Britzelmaier & Burger, 2012; Grimmer & Bingham, 2013), and doubt and dissatisfaction about products and manufacturers (Lemke & Luzio, 2014). Sometimes green products do not support consumer needs, which leads to poor perceptions of them. So, high pricing,

and low confidence can make this situation worse (Pedro Pereira Luzio & Lemke, 2013). Other studies also support these ideas and have found that providing additional information about the benefits, performance, and quality of environmentally friendly products can have positive impacts on green purchase behaviours (Grimmer & Bingham, 2013; Heikkurinen, 2010; Rodriguez-Melo & Mansouri, 2011; Sandhu et al., 2010; Tilikidou, 2013). Auditing the perceptions of people to find how a product is valued, understanding their present and future lifestyles, and knowing how they communicate with media, can help to give a green product a positive image (Bendell & Kleanthous, 2008).

3.1.1.1 Effect of socio-demographics

Different studies have recognised the influence of socio-demographics on green buying behaviour in order to profile green consumers and help companies to position green brands (Diamantopoulos, Schlegelmilch, Sinkovics, & Bohlen, 2003; Finisterra do Paço & Raposo, 2010; Kalantari, Fami, Asadi, & Mohammadi, 2007).

Generally, demographic characteristics such as gender (Shrum, McCarty, & Lowrey, 1995), education (Tilikidou, 2013), and racial and cultural background lead to different conceptualizations (Guerci, Longoni, & Luzzini, 2016; Sandhu et al., 2010), which affect the relationship between consumer value and consumer satisfaction with buying behaviour. For example, women are more concerned about social issues, and men respond better to emotional communication (Hur, Woo, & Kim, 2015). Therefore producers and suppliers can communicate rationally rather than emotionally with buyers with regard to sex and age (Sonnenberg et al., 2011).

Mostly it is women who exhibit more positive environmental attitudes (Kalantari et al., 2007; K. Lee, 2009; Mainieri, Barnett, Valdero, Unipan, & Oskamp, 1997), as well as being more positive towards green consumption (Jain & Kaur, 2006; K. Lee, 2009). Younger respondents are also more willing to use green products (Jain & Kaur, 2006), and people with higher education levels and greater income are more willing to be green consumers (Jain & Kaur, 2006). Older people, those who are more educated and with higher incomes are more likely to behave environmentally (Grant, 2011).

Earlier studies have shown that younger respondents, with higher educational level and more income, which generally means they are in a higher social class, who live in urban areas, and who have a liberal orientation are more environmentally concerned. Also there is the so-called “white

male” effect in that this group seems less concerned about environmental issues (J. Shen & Saijo, 2008), although those with lower incomes recycle and recover recyclable elements in greater proportions (Chung & Poon, 1999).

The reasons behind these results can be explained in different ways and these are summarised as follows:

- The younger generation are less involved in decision-making or groups where people might discuss the pros and cons of a solution to environmental problems, so they are not aware of disadvantages of some of the solutions. Since they think more positively about the solutions, and easily grasp information about environmental issues, we can say they think less critically. However, in some cases when parents care so much about their children and the next generation this is why they are concerned about environmental deterioration, as this could cause problems for their children more than for themselves.
- The “white male effect” concerns the power of white men to make decisions which could leave women or minorities at environmental risk or harm. In some societies where men are more politically active, and have higher educational levels they may be engaged in more economic activities compared to women, and see dealing with the environment as being in the way of these.
- The social class effect is defined by the level of education and income. If being environmentally friendly is a characteristic of people who have met their basic needs, this would explain the social class effect, although there are always exceptions to this.
- Objective physical conditions, and living in areas where you can feel the signs of environmental deterioration can affect the level of being concerned about environmental issues. For example, people who live in cities are more exposed to different pollution types, like air or water pollution.
- There is the fact that business and industry are more conservative and this can mean they will resist extensions to regulations and innovative actions to solve environmental problems.

The question is whether the same attitudes and values associated with green buying behaviour will apply when it comes to the use of RRBMs. As yet there has been no study that has looked at this area. It is also important to study the social bases of the sample population and thus explore the

background of the respondents more in depth. Adding these aspects to examining the environmental attitudes of a sample population will lead to better comprehension of environmental orientations (J. Shen & Saijo, 2008).

3.1.2 Environmental paradigms

Research into environmental attitudes has led to the development of environmental paradigms for measuring these. Weinreich (2010) proposed a concept or a step by step guide for understanding how people's behaviours change over time. Steps in this process include; believing that the situation is at risk; understanding how the proposed action can mitigate the consequences; understanding that the benefits outweigh the costs; having the intention to change and having enough skills to do so; consistency of the idea; and the pressure of social norms and being able to overcome barriers (Weinreich, 2010).

Behaviours that would help conserve the environment are also known as pro-ecological behaviours (Steg & Vlek, 2009). Based on a definition by Kurisu (2015), behaviours that are "conducted through the motivation to conserve the environment and actually contribute to environmental conservation" are mainly pro-environmental behaviours. Sociodemographic environmental attitudes can indirectly affect environmental behaviours. Research by Steg and Vlek (2009) showed promotion of pro-environmental behaviours is usually more effective "...when they are systematically planned, implemented and evaluated." Thurstone became known for his studies on people's attitudes, and in the late 1920s described attitude as "the total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic" (Thurstone & Chave, 1929). This definition can also be extended to environmental attitudes.

Based on a review of the early studies in this area by Kurisu, none indicate that there are universally consistent relationships between sociodemographic characteristics and pro-environmental behaviour. That is, each study is done within its own time and space context and the findings have generally varied with these differences. Nevertheless, reading across earlier studies it becomes apparent that environmental attitudes correlate more strongly with age, education and income characteristics (Kurisu, 2015). Environmental attitude does not always lead to a corresponding environmental behaviour as a number of barriers, some well-known and others less so, have been identified. Based on a review by Kurisu (2015), there are some contradictions between different

studies about the influence of attitudes on behaviour; for example, they try to show that they care about the environment but their real behaviour is not as environment friendly as they claim.

Several different environmental attitude scales have been developed, including: the “New Environmental/Ecological Paradigm” by Dunlap and Van Liere (1978), where 6, 12 and 15 item scales capture a person’s general environmental beliefs, and the “Ecocentric, Anthropocentric, and Environmental Apathy Scale” by Thompson and Barton (1994), which is a 33-item scale with which to measure the general apathy held for the environment. Others are the “Ecological World View Scale” by Blaikie (1992), which includes 24 and 17 items mixing the two scales of Dunlap and Van Liere; the “ENV Scale” by Bogner and Wiseman (1999) comprising 69 items organised in two dimensions and five sub-factors; and the “Milfont and Duckitt Scale” by Milfont and Duckitt (2010), which includes 99 items selected from the Dunlap, Balikie and Bogner scales.

Among these, the New Environmental/Ecological Paradigm (NEP) is the most widely used scale as it measures the general beliefs of people and not specific environmental issues (Hawcroft & Milfont, 2010). The original New Environmental Paradigm comprised 12 items (Dunlap & Van Liere, 1978), which some researchers have subdivided into three dimensions. In 2000, this scale was renewed by Dunlap and Van Liere with 15 items, taking into account broader ecological worldviews and some new terminologies. In 2008, a short version of six items was developed by them, and this is the scale that is used in this study. Original items number 2 and 9 are used with the original wording, item number 6 has been reversed from the original and items number 3, 11 and 4 are revised items regarding wording and concept (Table 9) (Kurusu, 2015). This 6-item scale was first used in 1982 in a national survey for the Continental Group (Arcury, 1990), but later different researchers from various disciplines who did not have enough space for the longer versions also used the 6-item scale. There is evidence from different studies that the NEP scale possesses criterion, content and construct validity (Dunlap et al., 2000).

While Dunlap conceived of the NEP as being one dimensional, Albrecht et al (1982) proposed it should be considered in three dimensions, with “balance of nature”, “limits to growth” and “man over nature” encompassing the first item, the second and fifth items, and third, fourth and sixth items respectively.

A high NEP score shows a positive attitude towards the preservation of natural resources and a low score shows a positive attitude towards the exploitation of natural sources. The NEP scale is measured using a five-point Likert scale and items are coded from 1 = “strongly disagree” to 5 =

“strongly agree”, with 3 being “neutral”. The mean score of each item and the whole scale can be calculated based on these points. Numbers of previous items show how the 6-item scale has been extracted from the earlier version (see appendix 7) (Table 9).

Table 9. The short version of the NEP scale (Kurusu, 2015)

Previous item number	Item	New Environmental Paradigm scale
2	1	The balance of nature is very delicate and easily upset by human activities
9	2	The earth is like a spaceship with only limited room and resources
6R	3	Plants and animals do not exist primarily to be used by humans
3*	4	Modifying the environment for human use seldom causes serious problems
11*	5	There are no limits to growth for nations
4*	6	Mankind is created to rule over the rest of nature

R: reversed from original, *: modified

3.1.2.1 Differences in environmental attitudes

Table 10 presents a summary of the results from previous studies in the United States, the United Kingdom, Australia and New Zealand that resulted in NEP scores. Most of the studies conducted in New Zealand have used a 6-item scale.

An investigation was carried out by Shephard and his colleagues (2009) to benchmark environmental values of higher education students in Dunedin using a modified, 15-item version of the NEP scale (Shephard, Mann, Smith, & Deaker, 2009). Another study by Higham et al (2001) investigated ecotourism in New Zealand, with most of the participants being New Zealanders (Higham, Carr, & Gale, 2001). The Waikato Regional Council carried out studies over a number of years, providing a longitudinal assessment of environmental attitudes (Versus Research Ltd, 2016).

A meta-analysis of earlier studies was conducted by Hawcroft and Milfont (2010), in which NEP scores returned over a 30-year period were reviewed. This analysis revealed that environmentalists and white-collar participants usually return a higher score than their blue-collar counterparts. It also appears that education levels have a positive correlation with NEP scores. The results of this meta-analysis could be useful for checking the validity of the findings of other similar studies. Hawcroft and Milfont (2010) also noted that the 6-item scale tends to return higher overall scores than other

versions. One reason for this may be that the six items do not include statements about “ecological catastrophe or crisis” and, logically, people are concerned more with their treatment of the environment than causing a catastrophe. It should be further noted that overall results and the relationships between responses to individual items on the scale can still be correlated between the 6-item and larger scale versions of the NEP. A summary of NEP studies is given in table 10.

Table 10. Summary of some comparable NEP studies

Study	Scale length	Country	Mean	SD	α	Target population	Size
Barr and Gilg (2006)	6	UK	3.98	.59		public	1214
Pahl, Harris, Todd, and Rutter (2005)	15	UK	4.22		.86	environmentalists	45
Hunter and Rinner (2004)	15	USA	3.81	.73	.87	public	398
Cottrell (2003)	12	USA	3.90		.82	white-collar	226
Dunlap et al. (2000)	15	USA	3.75		.83	public	676
Kotchen and Reiling (2000)	15	USA	3.65		.83	public	206
	15	USA	3.61		.83	public	200
Schultz, Unipan, and Gamba (2000)	12	USA	2.75		.77	blue-collar	39
Steel, List, Lach, and Shindler (2004)	6	USA	4.30	.49	.81	white-collar	155
	6	USA	3.97	.64	.81	white-collar	167
Steel, Lovrich, Lach, and Formenko (2005)	6	USA	3.77	.77	.79	public	3204
Steel, Smith, Opsommer, Curiel, and Warner-Steel (2005)	6	USA	3.89	.75	.79	public	1176
Bissing, Olson et al. (2013)	15	AUS	3.56	.57	.86	different occupations	56
Kurz, Donaghue, and Walker (2005)	15	AUS	3.62	.44		different occupations	93
Higham, Carr and Gale (2001)	12	NZ	3.52	.98		different occupations	967
Waikato Regional Council (2013)	6-15	NZ	3.84-3.80			public	1005
Waikato Regional Council (2008)	6-15	NZ	3.67-3.67		.42	public	600
Waikato Regional Council (2004)	6	NZ	3.50		.62	public	528
Waikato Regional Council (2000)	6	NZ	3.84		.63	public	1873
Shepard et al. (2009)	15	NZ	2.50	1.00	.75	student	539

3.1.3 Theory of Planned Behaviour (TPB)

Since the 1980s, predicting environmental behaviour has been an evolving area of research in environmental psychology, with several theories having emerged since that time, including Ajzen's (1991) TPB. According to Klöckner's (2013) study, the TPB is one of the most commonly used models in this domain when it comes to green product purchase and recycling behaviour. The TPB is a hypothetical model with which to study influential factors on this behaviour. In the TPB, factors to be studied are attitude, subjective norm, and perceived behavioural control (perceived capability). Results of a study by Li et al (2015) showed that attitudes and perceived behavioural control have positive impact but subjective norm plays a limited role.

TPB variables are more useful in the prediction of environmental behaviour compared to the Norm Activation Theory by Schwartz (1977) and the Value Belief Norm Theory by Stern (1999) (Klöckner, 2013). The generalized Norm Activation Theory describes beliefs about responsibility for causing consequences to any valued objects and the Value Belief Norm Theory says that people who think that valued objects are threatened believe they can save them depending on their capabilities and constraints (Stern, Dietz, Abel, Guagnano, & Kalof, 1999). Klöckner states there is much experimental and practical evidence behind the TPB. The main determinants of this model are shown in Figure 12, which has been adapted for this study. The concept of this model is that the behaviour depends jointly on motivation and ability. Motivation is the intention and ability can be a collective of different factors, such as the context of the opportunity, and facilitating factors and resources that shape the control of the behaviour.

In the TPB, motivation or intention is essential, and has a direct relationship with the previous factors (Ajzen, 1991). Based on the findings of other studies supporting the TPB, these three factors have an influence on behaviour via intention, but the perceived behavioural control factor also has some direct influence (Li et al., 2015). The TPB has been applied to other relevant fields such as household waste reduction and recycling (Bortoleto, Kurisu, & Hanaki, 2012; Ramayah, Lee, & Lim, 2012; Steg & Vlek, 2009; Tonglet, Phillips, & Read, 2004).

Figure 12. TPB, adapted from (Ajzen, 1991)

Li et al. (2015) came to the conclusion that attitudes and perceived behavioural control could have significant influence on implementing waste reduction strategies at the design stage. They measured perceived behavioural control by asking about perceived difficulties and controllability of the situation. However, the subjective norm (see 1.3.2) was not found to have been influential. Among these factors, perceived behavioural control was the most influential factor for designers based on their self-reported rather than observed behaviour. Nevertheless, there are studies with contradictory results like that of Davies et al (2002) who demonstrated that intention is not indicative of behaviour.

Most of the studies in this field support Ajzen's TPB on the basis that understanding attitudes can better help to explain behaviour (Begum et al., 2009). Earlier studies of Ajzen and Fishbein (1980) regarding the unresolved issues of planned behaviour showed that many studies which failed to show correspondence between attitude and behaviour are because attitudes and behaviours were not specified correctly (Ajzen & Fishbein, 1980), or the target population even for the same behaviour responded differently (Balderjahn, 1988; Granzin & Olsen, 1991; Pickett, Kangun, & Grove, 1993). Therefore, it seems that combining factors from a wide range of behaviours or different dimensions of attitudes may mask the real relationship that exists between attitude and behaviour (Roberts & Bacon, 1997). Also, there is evidence for a relationship between environmental attitude and recycling activities, not values (Hines, Hungerford, & Tomera, 1987; Vining & Ebreo, 1992).

3.1.3.1 Environmental world view

Understanding the perceptions of people regarding environmental issues is vital when it comes to solving environmental problems and consequently improving ecological sustainability. Hence, through history researchers have tried to establish sound instruments with which to study and

measure environmental attitudes. Hundreds of different measures for assessing environmental attitude exist, and Ogunbode (2013) has called these the “anarchy of measurement”, although the New Environmental/Ecological Paradigm (NEP) scale with its documented validity and reliability stands out among other instruments. Since having positive environmental attitudes is an important antecedent of pro-environmental behaviour, examining the level of environmental attitudes is essential for the promotion of the latter (Ogunbode, 2013). Besides, in more affluent countries like New Zealand, environmental actions are more influenced by morality, so can be predicted by attitudes (Thøgersen, 1994). However, based on a meta-analysis, factors like legislation and the opportunities that authorities provide, and the type of residence affect environmental behaviour. Klöckner’s (2013) review of studies also shows that having positive attitudes towards the environment is associated with its conservation.

The NEP scale is one of the richest measurement tools for predicting behaviour from attitudes (Roberts & Bacon, 1997). Studies have proven a significant relationship between NEP scale results and self-reported or observed environmental behaviours (Casey & Scott, 2006; Rauwald & Moore, 2002).

3.1.3.2 Subjective norms (SN)

The subjective norm can be defined as an individual’s perceptions of general social pressure to perform a behaviour (Armitage & Conner, 2001). Recycling is a behaviour influenced not only by personal motivation but also by community and social motives (Klöckner, 2013). Based on a study by Biswas and Roy (2015), the strongest motivation comes from peer opinion and social recognition, which is shaped from positive word of mouth and socio-cultural practices. One of the prominent factors in recycling is the social impact which involves all stakeholders ranging from architects and regulators to consumers (Dursun et al., 2016). Kumar and Ghodeswar (2015) also identified social appeal as an influential factor in green product purchase.

Although there are conflicting results from studies, with some showing subjective norm to be the weakest predictor, recycling as an altruistic behaviour is influenced by social pressure and the need to comply with this (Khare, 2015; Klöckner, 2013). Two meta-analyses by Armitage (2001) and McEachane (2011) have shown the subjective norm is a weak predictor among other TPB factors and other authors have argued that it is the weakest predictor of intention and behaviour, and accordingly some authors have removed it from analysis (Armitage & Conner, 2001; McEachan,

Conner, Taylor, & Lawton, 2011). Another meta-analysis indicated the subjective norm is commonly measured as a single item (Hardeman et al., 2002).

3.1.3.3 Perceived behavioural control (PBC)

Klößner (2013) used Ajzen's (1991) definition of perceived behavioural control in his earlier research as "the person's belief as to how easy or difficult performance of the behaviour is likely to be". This definition can be extended to internal factors like abilities and knowledge, and external factors like opportunity and the cooperation of other stakeholders that lead to the behaviour.

There is no specific scale with which to measure PBC. One way is to ask respondents about their perceptions of their capabilities to engage in waste reduction activities; the other is to ask their perception of the opportunities and obstacles they see in the way (Davies, Foxall, & Pallister, 2002; Li et al., 2015). The second way of measurement, which is belief-based, is known as a better predictor than the direct measure (Klößner, 2013) and has been used in this study. For discussion of factors to be studied for PBC including transparency of information, economic incentives, policies, personal relevance, and convenience (see section 1.1).

One of the findings of similar studies is that mere environmental concern does not necessarily lead to environmental behaviour. Given this, marketing professionals should not only use green production but also pay attention to the functional, emotional and experiential needs of society and give enough information about environmental performance congruent with desirable social image and lifestyle (P. Kumar & Ghodeswar, 2015)

3.1.3.4 Intention (Int)

Lack of motivation is one of the barriers to reducing waste (Chung & Poon, 1999). Based on the results of studies, people are more concerned about environmental problems which they see and that have an immediate and direct impact on their lives, such as pollution and waste management (Babalola, Babalola, & Okhale, 2010; Ogunbode & Arnold, 2012). In the TPB, the intention is to find a determinant that can be called a plan for the behaviour that in conjunction with other factors enables the person to perform environmental behaviours. Intention has thus always been a concern for psychologists (Klößner, 2013).

3.1.3.5 Behaviour (Beh)

While this aspect of the TPB has been examined for different environmental behaviours in many studies, the focus of this study is the construction industry and the specific environmental behaviour is the reuse and recycling of building materials and the use of RRBMs in building construction and the stakeholders involved in the latter. The behaviour of stakeholders in reducing construction waste can be measured by asking them about it. This study has relied on self-reported rather than observed behaviour. Preparing the design proposal for consideration by the client is the responsibility of architects and designers, so they are prime candidates in initiating change. The primary motivation in the first stages of designing a building are the ideas and interests of both client and architect (Addis, 2012). Clients of building projects are indirect consumers of building materials, and studies suggest that the purchasing behaviour of consumers is one of the main factors that defines the values of the market (Bendell & Kleanthous, 2008), so altering purchasing behaviour could move the market to being more environmentally friendly.

3.2 Stakeholders

Freeman (1984) defined stakeholder as “any group or individual who can affect or is affected by the achievement of the organisation’s objective”. Architects, builders and contractors, manufacturers and suppliers, NGOs and environmentalists, regulators, and consumers are here considered to be the main stakeholders of the building construction process. Looking at a number of stakeholders can be helpful in creating a multidimensional conceptualisation towards a more sustainable approach (Luchs et al., 2015). Understanding attitudes and behaviour is crucial in solving the problem of waste management in the building construction process and a collective effort from all involved parties is necessary in order to move towards successful waste management in practice (Begum et al., 2009; Lu & Yuan, 2010).

In their study of attitudes and behaviour related to waste management, Prasnikar et al. (2012) focussed on contractors, site managers and labours (Prasnikar, Ograjensek, Pahor, Bajde, & Trobec, 2012). Esa, Halog and Rigamonti (2017) believed stakeholder opinions are important in solving problems in the building construction process since it is labour intensive, and they found that stakeholders in the construction industry in Malaysia care about the environment, and are interested in helping the environment through reducing C&D waste. An earlier study by Tam (2008)

showed that government was more willing to minimise C&D waste than contractors, clients, and designers. Another study by Shen and Tam (2002) showed the major barrier against appropriate environmental practices was the lack of training and expertise in the construction industry. Lu and Yuan (2010) showed in their study that successful waste management plans in construction projects involve the active participation of all actors. More specifically not having proper communication between stakeholders (Domingo & Luo, 2017), comprehensive strategies, consistent views (Saez, del Río Merino, González, & Porras-Amores, 2013), and previous experience can influence the perceptions and ultimately the behaviour of stakeholders in terms of executing a waste minimisation plan or buying recycled content products (Jin et al., 2017).

3.2.1 Roles and influence of stakeholders

Below are summarised the roles and influence of stakeholders in the construction process:

- Rotmans, Kemp and Van Asselt (2001) argued that the government can, and ought to, be a leader in any sustainable transition in a society; as a facilitator, stimulator, controller, and director. National, local and regional governments all have roles depending on the type of change and their closeness to other actors. However, there are always external aspects, political structure and socio-cultural factors that influence this role. A study by Kalantari et al (2007) focussed on the role of government and environmental legislation in protecting the environment through the green buying behaviour of consumers, concluding that educating people can improve their environmental attitudes to help the environment but with the help of environmental legislation.
- Non-governmental organisations (NGOs) or environmentalists have some influence on changing public attitudes and persuading consumers towards more ecological behaviours (NZAIA, 2016; Zero Waste Network, 2020). So, they can have not only an effective voice among people and communities, but at Government level to lobby the environmental issues (Community Recycling Network, 2017; Sandhu et al., 2010).
- Begum et al (2009) found that large contractors, with more educated employees, with past experience and training of waste reduction, more experience in construction activities and in disposing of waste to landfills, and contractors with the belief that waste is harmful to human health have more positive attitudes towards waste management. On the other hand,

small contractors showed more satisfactory behaviours in terms of waste management and newly registered contractors were more conscious about this issue. Overall, the results showed that behaviours related to recycling practices at source have a positive influence on attitudes towards other waste management approaches. However, one of the interesting findings of this study was that majority of contractors (70%) did not sort waste on-site unless it was part of the contract.

- Based on a study by Osmani et al. (2008) 33% of waste in the construction process is because of weakness in the design stage. This suggests design is one of the most important stages for reducing waste as design and material choice is really dependant on the design professionals. Therefore, the attitudes of designers towards waste minimization should be examined to find the predictors of waste management implementation (Li et al., 2015).

There are different ways for the designer to minimize waste on site, such as being careful about dimensions, using prefabrication components, reducing modifications, preparing a detailed design before work starts, and using RRBMs (Baldwin, Shen, Poon, Austin, & Wong, 2008; Jaillon et al., 2009; Osmani, Glass, & Price, 2008; C. Poon & Jaillon, 2002; Tam, Shen, Fung, & Wang, 2007; Villoria Saez, del Río Merino, San-Antonio González, & Porras-Amores, 2013; Zhang, Wu, & Shen, 2012). These studies suggest the role of the designer is critical, but only a few have investigated their role, attitudes, and practice (Hao & Kang, 2010; Osmani, Glass, & Price, 2006; Osmani et al., 2008; J. Wang, Li, & Tam, 2014), and very little research has tried to study the different factors quantitatively (Li et al., 2015).

One study found architects did not give priority to waste reduction when they were designing a project (C. S. Poon, Yu, & Jaillon, 2004), and another that they do not believe they can reduce waste during design as much as during site operations (Osmani et al., 2006). Also designers are not sufficiently trained to know how to reduce waste during the design process (Ekanayake & Ofori, 2004). However, designers who are interested enough to shift their designing towards waste minimization have to find out for themselves how to do this as there is a lack of formal training in this area (Hao & Kang, 2010; Osmani et al., 2006).

- Manufacturers and suppliers are the stakeholders who should think about the whole supply chain and consider the effects of each step in the life cycle of materials (MfE, 2018).

Being more conscious of the future limits of natural resource availability is changing many manufacturers and suppliers into green suppliers. This trend towards more socially and

environmentally benign behaviours by manufacturers was first only an ethical approach, but slowly it has become a necessity driven in part by their perceptions of stakeholder expectations and market demand (Albino et al., 2009; Rodriguez-Melo & Mansouri, 2011; Slaughter, 2013).

For manufacturers to meet expected future market demands and be successful, they will need to consider concepts of sustainability in their own practices, including use of green products. By finding sustainable alternatives, businesses can cut costs as depletion of natural resources will cause prices to increase. In doing this they can also benefit from sustainable decisions being more appealing to customers and investors. Building strong relationships with customers, investors, and staff can play an important role in establishing a market (MfE, 2005).

Effective environmental strategies are also opportunities for competitive advantage, since managing conflicting stakeholder interests and being seen to be responsible can increase profitability from sustainable practices and environmental strategies. This can also be a motivation for manufacturers to be more environmentally friendly and innovative (Driessen & Hillebrand, 2013; Rodriguez-Melo & Mansouri, 2011).

- Apart from the lack of interest of designers in waste minimization strategies, clients are also not interested which is a big barrier (Baldwin et al., 2008; Osmani et al., 2006). Consumers are the people who decide to throw away products after use and before they are worn out, and are also the people who can opt for products with less adverse effects on the environment, but this is only possible when they have enough information to help them make decisions (MfE, 2018).

3.3 Summary

Studies have shown that environmental attitude can have a positive influence on green purchase activity, and reuse and recycling behaviour. It is also easier to encourage people with an environmental orientation to take these actions through education. This literature review has revealed that green purchase behaviour is influenced by social pressure, personal satisfaction, the image of the company, transparency of information, cost, having coherent policies, convenience, and having no gap between claims and performance.

Socio-demographics have been studied to examine their influence on attitudes and behaviour, since they may lead to different conceptualisations. Age, gender, education, income, occupation and residency situation can influence environmental concerns. These influences and relationships are not consistent between different studies, although age, education, and income are more strongly correlated with attitudes and behaviour.

NEP is the most widely used scale for measuring environmental orientation and the short version is an integrated questionnaire with 6 items. A meta-analysis reviewed a large number of studies and indicated that white-collar participants have more positive environmental orientations than blue-collar workers. This is important for this study as the construction industry has both worker types, but co-operation between them has also been shown to be important in C&D waste minimisation.

In order to examine the relationship between attitudes, behaviour and other determinants, the TPB has been discussed in this study, as this is one of the most commonly used models for predicting environmental behaviours. Determinants to be studied based on the TPB are attitude, subjective norm, perceived behavioural control, and intention. These determinants can have a direct or indirect relationship with behaviour. Studies have shown that in waste minimisation strategies, attitudes and perceived behavioural control are more important over subjective norm in predicting the behaviour. However, earlier research proved the importance of these factors can vary in different case studies. The relationship between attitudes and behaviours is stronger in affluent countries. Subjective norm, the perception of social pressure, is known to be the weakest predictor. Perceived behavioural control concerns the abilities, knowledge, and external factors that should be specifically framed for each case study and is a belief-based factor. Motivation or intention is a factor that in conjunction with other factors can enable people to undertake environmental behaviours. The self-reported behaviour measured in this study is reuse, recycling of C & D waste and the use of RRBMs. This is similar to studies that have looked at purchasing other products, and undertaking environmental behaviours in other industries.

Part Two of the literature review has found that investigating multiple stakeholders in a single study has advantages over focusing on one group, and is helpful in creating a multidimensional conceptualisation of the problem. Some research has targeted different stakeholders in the construction process to examine their environmental attitudes and their opinions of waste management. One study showed that the government is more willing to minimise C&D waste than other stakeholders. Barriers identified were lack of training, expertise, cooperation, communication, consistent views, and previous experience.

The roles and influence of different construction industry stakeholders, including regulators and those who implement regulations, NGOs and environmentalists, builders and contractors, architects and designers, manufacturers and suppliers, and consumers or clients have been studied in the literature. At different levels, the government usually has the role of being a leader, facilitator, simulator, controller and director. NGOs can influence public attitudes and can lobby government. Builders and contractors can institute waste management plans, and train their crew in implementing these. Design professionals can reduce C&D waste through design and material choice, and part of this task is negotiating with clients, which is a type of education through giving them required information on RRBMs. This is why their role is critical. There have been very few studies in this area, and those that have been done would not be generalisable since their sample population was not large enough.

In order to make wise decisions in design and material choice, designers should also be educated. This mainly takes place during their tertiary based professional education and training. Unfortunately, there is a lack of evidence of formal training in this area. Manufacturers should also consider the whole life cycle of materials and components. This is not only beneficial for the environment, but also for themselves, because of the future limits regarding natural resources, and the growing market demand. The interest and mind-set of clients or consumers is always a barrier in the market. Their willingness to use RRBMs only happens when they are well-informed, but other obstacles like cost, constructability and regulations could also influence their material choices (Balador, Gjerde, Isaacs, & Shabahang, 2018).

3.4 Knowledge gap

A number of studies have investigated C&D waste reduction, particularly the main contributors to waste generation, and recycling (see section 3.1.1 and 3.2.1). Apart from the fact this area still needs to be investigated to solve technical aspects, there is a need for more research on how to promote and encourage C&D waste reduction. One way of doing this could be to study the perceptions of stakeholders regarding waste minimisation and the use of RRBMs, and thus find the challenges and opportunities through understanding their views.

One of the obstacles against waste minimisation recognised in the literature is cooperation, communication, and the mind-set of stakeholders (see section 3.2.1). This has not been studied

enough in the construction industry which is a labour-intensive industry, creating many different actors and stakeholders that of necessity have to communicate with each other. Driessen and Hillebrand (2013) also stated that there are few studies which focus on the cooperation of multiple stakeholders, and other researchers also believe that analysing attitudes and awareness is helpful for understanding the situation more deeply (Bhate, 2002; Rodriguez-Melo & Mansouri, 2011).

Considering the fact that RRBMs are a type of green product, studying the perceptions of consumers of RRBMs is also valuable, and this has not yet been done. As market analysis shows, the results of green purchase behaviour studies are more reliable when they are for a specific location, a specific industry, and a specific product (Albino et al., 2009; Haryanto & Budiman, 2015; Paulraj, 2009). There is also the controversial issue as to what is the effective driving force behind green purchasing (Sandhu et al., 2010). Studying multiple stakeholders in one study has the advantage of creating a multidimensional and more comprehensive perspective for solving the challenges involved in promoting environmental behaviour.

Studying the perceptions of stakeholders in the building construction industry could show a different pattern from other industries, such as the car industry, because architects and designers, as one stakeholder group, may have a great influence on the final product selection. Design professionals have a critical role in wise design and material choice to reduce waste minimisation, so investigating their role and perceptions is an added value.

Above all, the lack of research into attitudes and behaviour and reducing waste in the New Zealand construction industry was a trigger for commencing this study. Finding opportunities and challenges of using RRBMs based on the stakeholders' perceptions should be beneficial and provide a holistic view to increase the use of RRBMs in the New Zealand construction industry.

4 Methodology

4.1 Description of the research problem

This research investigates the role of architects as decision-makers, in selecting and specifying recycled building materials in the building construction process, through comparing the role they play with those of other stakeholders in the RRBMs market. Ambiguities in the perceptions of stakeholders about their roles, expectations, interrelationships, and demands will be explored and documented. The research aims to identify the stakeholder group(s) with the greatest potential to influence the increased use of recycled building materials, and any constraints on this outcome.

4.2 Introduction

At times there is a need to explore a problem and to show the complexity of it, to hear the voice of participants and to convey their perspectives. In these instances, qualitative approaches are recommended. At other times the need is to understand relationships and differences, and this is when quantitative approaches are recommended. This study seeks to look for both a detailed and general understanding of the issue, so this topic is suited for the mixed-method approach. In applied areas of science, when more explanation of quantitative data is required, it is possible to take advantage of qualitative data that also engages different disciplines and multiple tools, so as to strengthen both methods. In other words, a particular design is adapted to the study purpose and the shift is from the post-positivist to constructivist positions in the two phases of the study. The interaction between phases occurs at different points, but here a greater weight has been placed on the quantitative method.

An explanatory sequential, mixed-method research process has thus been designed. This involves collection of quantitative data through an online survey questionnaire in selected cities of New Zealand using the Qualtrics platform. Alongside this, in-depth qualitative data was collected from focus group discussions to support the quantitative methods and help explain the results. Six main groups of stakeholders (600 people) in the field of the use of RRBMs participated in the first phase. The six groups were architects and designers, builders and contractors, NGOs and environmentalists, manufacturers and suppliers, regulators and related institutes, and consumers. Focus groups were later conducted with the most influential stakeholders based on the results of

the first phase. Out of 250 contacts, 22 people participated in separate focus groups based on their professions.

4.3 Philosophical justification of methodologies

Conducting research needs to have philosophical foundations. This knowledge of philosophies will help to articulate assumptions in the research. These philosophical assumptions inform the research design and methodology, and the methods or techniques it incorporates (Figure 13). These philosophical foundations can be used synonymously as a worldview or paradigm since they are a basic set of shared beliefs and values that guide the research (Leavy, 2017).

The worldview also dictates the methodologies. Multiple paradigms can be combined in a mixed-method study. Post-positivism and Constructivism are two important worldviews. Post-positivism informs quantitative approaches based on cause and effect thinking and focuses on the interrelationship of selected variables. Constructivism works from a different worldview and informs qualitative approaches based on the subjective views of participants, which are shaped by social interactions and their own personal histories in order to reveal broad patterns. If using both quantitative and qualitative approaches in the same phase, it might be better to consider pragmatism as the worldview, since it involves a pluralistic stance for data collection. In this research the study begins with an online survey questionnaire, then moves to focus groups based on the results of the first phase. Therefore, there is a shift from a post-positivist to constructivist view point that means the worldviews change with the type of research undertaken (Creswell & Clark, 2007).

An early stage in research is finding the right methodology. At times a problem needs to be explored to show its complexity. In this instance, to hear the voice of participants and convey their perspectives, a qualitative study is recommended. At other times the need is to understand the relationships and differences between things, so a quantitative study is better. Therefore, this topic is suited for mixed-method as one data source is insufficient because the need is to have both a detailed and a general understanding. The great advantage of a mixed-method is offsetting the limitations of one method by strengths of the other. When quantitative results need more explanation, qualitative data can reveal a more detailed understanding of them (Laycock, Howarth, & Watson, 2016). Besides, complex problems need a more comprehensive methodology. A call for more sophisticated evidence by those in applied areas of science, such as policy-makers and

practitioners, leads to the use of mixed-method supported by quantitative and qualitative data (Howell, 2012).

Figure 13. Philosophical background guiding the research design

Each discipline has a specific methodological comfort zone, which means that researchers in that area prefer to work through accepted and popular methodologies. By moving outside this comfort zone, more generalizable and contextualized data can be collected, compared to the sole use of either qualitative, or quantitative methodologies. A mixed-method approach offers a different vision of the research problem, being led by the research question type. Consequently, the results will be more explainable because they are the outcome of deductive and inductive procedures, and also engage different disciplines (Hay, 2016).

Each discipline has some overlap with other disciplines and this relatedness of topics can help through sharing knowledge. This also holds true for methodologies. Using mixed-method was first started by recognizing the value of using different methods (quantitative and qualitative) as a basis for making substantive connections across varied disciplines, rather than viewing them as polar opposites (Hay, 2016).

Mixed-methods research can help in the examination of complex problems, especially in interdisciplinary areas, through the use of multiple tools that can strengthen both quantitative and qualitative methods and minimize each of their weaknesses. The study may not fit into one specific approach, so knowing the nature of the knowledge needs to inform every aspect of the study including the research questions, data collection, data analysis, and data interpretation (DeCuir-Gunby & Schutz, 2017).

4.4 Methodological approach

4.4.1 Classification

A mixed-method research design can be fixed or emergent. Where the study is planned before the research starts it is a fixed design, but when issues come up and another approach is needed it is an emergent design. In other words, emergent design is research design based on the results as they emerge (Creswell & Clark, 2007). This study sits somewhere between fixed and emergent mixed-method design since having the focus groups was decided from the beginning, but the detailed design of these emerged based on the results of the questionnaire and the issues that arose when collecting the data. In addition to being somewhere between emergent and fixed, the design approach of this study falls into the typology based approach. This is because a particular part of research design is selected and adapted to the study purpose (Creswell & Clark, 2007).

4.4.2 Mixed-method research design

The research design is an explanatory sequential design. It starts with the quantitative study and analysis of the data. Then the qualitative study follows based on the results so the researcher can interpret the initial results using the qualitative data. This approach is implemented to assess trends and relationships found in the quantitative data and to explain the mechanism and reasons behind them, making this one of the most straightforward mixed-method designs (Table 11) (Leavy, 2017).

Table 11. Prototypical characteristics of explanatory design adapted from (Creswell & Clark, 2007)

Prototypical characteristics	Explanatory design	Prototypical characteristics	Explanatory design
Definition	Phase1: quantitative data collection and analysis, Phase 2: qualitative data collection and analysis based on Phase 1	Timing of the strands	Sequential starting with quantitative study
Design purpose	Explaining quantitative results	Primary point for mixing	Data collection
Typical paradigm foundation	Phase 1: postpositivist Phase2: constructivist	Primary mixing strategies	Connecting the quantitative data analysis to qualitative data collection. Research question, sampling and data collection in Phase 2 are defined based on Phase 1.
Level of interaction Priority of the strands	Interactive Priority of quantitative study	Common variants	Follow up explanations, participant selection

4.4.3 Level of interaction, priority and timing

There is a direct interaction between the quantitative and qualitative phases of this study, although this occurs at different points. In this study, greater weight has been placed on the quantitative method, and the qualitative study is secondary. The quantitative and qualitative studies are sequential with the quantitative part first. The second data collection is shaped using the results of the first data collection. After analysing the quantitative and qualitative data separately, they will be merged together, and the final conclusion will reflect what was learnt from both phases of the study and from the combination of results (Creswell & Clark, 2007; Leavy, 2017).

4.5 Methods

Before starting the main data collection, a pre-test and pilot study was undertaken. Pre-testing the survey is the step before the pilot study by giving potential respondents the chance to review the questions. The pilot study is done to test the survey in the intended setting to check both the questionnaire and the administration process (Fink, 2003).

The explanatory sequential mixed-method research design used in this study involves collecting quantitative data through a survey in selected cities of New Zealand and then exploring and

explaining the quantitative results by using in-depth qualitative data collected from focus groups in Wellington.

The data analysis process includes the initial descriptive statistics analysis, main statistical analysis, testing of reliability and validity, and data integration. Before starting the analysis, data should be organized in terms of its categorization, cleaning, and storage. Then main analysis includes a series of statistical tests and content analysis. The qualitative analysis includes organizing and coding the data, combining codes into broad themes, and then translating themes into narratives. However, when it comes to integrating the quantitative and qualitative data, it is difficult to describe the method of interpretation. The narrative approach would involve discussing the results of both phases together thematically in the same document. Above all, there are some theories like TPB in which the data analysis occurs helps to connect the results to other studies in the literature (DeCuir-Gunby & Schutz, 2017).

4.5.1 Survey questionnaire

A survey is a tool for data collection with the purpose of directly asking about the knowledge, attitudes and behaviour of the people in the study (Fink, 2003). In this study questions are arranged in the form of a self-administered online questionnaire.

In a quantitative survey questionnaire, questions are asked to evaluate the hypothesis, and make predictions according to these primary data. This is a top-down process since conclusions are deduced based on analysis of these data (Fallon, 2016).

Sampling, designing the questionnaire and data management are explained in chapter 5. The three cities of Auckland, Wellington and Christchurch were chosen for this study. The sample in the first phase of the study was a portion of the main stakeholders relevant to the use of building materials in construction in New Zealand. Qualtrics as an online tool was used to recruit respondents. The online questionnaire was made by Qualtrics and then the link was sent to potential respondents by email. The objective of the questionnaire was to ask stakeholders about their perceptions of roles, expectations, and other influential factors, and survey items formulated based on the literature review and research questions. This phase of the research as an anonymous online survey questionnaire was approved by the Victoria University of Wellington Human Ethics Committee.

4.5.2 Focus groups

The very first ideas of running focus groups emerged in the 1930s when social scientists were searching to find new ways of conducting interviews such that the researcher would have a less directive and dominating role. It was felt people would feel relaxed in an environment with people like themselves, so they would talk about themselves in a more naturalistic and inductive way, which is the intent of the focus group. In the 1950s, market researchers needing to stay in touch with customers used focus groups, and in 1980s, other academics learnt this technique from the market research community (Krueger, 2014).

The researcher gathers together participants who have certain characteristics related to the study in a permissive environment to find clues and insights regarding a defined area of interest. Apparently, members of a focus group influence each other, but they should also enjoy sharing their perspectives and perceptions in this environment. It is better to avoid mixing people with different levels of power and expertise. The interviewer should be careful not to control or judge even with body language and give everyone a chance to speak (Krueger, 2014).

A focus group continues until the point is reached where no new ideas or information are gleaned from the members. The output from focus groups should be analysed across groups to find the patterns and themes, not individually (Krueger, 2014). In this study mini focus groups of four to six respondents were conducted according to the number of available respondents, time and resources. The original plan in this research was to have one focus group with each group of stakeholders, but this changed a little according to the emergent characteristics of this phase of the study. A subset of the participants in the quantitative phase of the study were contacted based on their interest to be part of the focus groups.

Focus groups shed light on quantitative data and the purpose was to understand feelings and comments in the discussions. Participants may not know detailed and specific information about the topic, but they can share their perceptions. This phase of the research being confidential discussion groups also needed to be approved by the Victoria University of Wellington Human Ethics Committee.

4.6 Discussion and conclusion

Apart from the strength and limitations of a mixed-method approach, explanatory sequential design has advantages and disadvantages. Benefits include the ease of writing up because research is divided into two parts. However, challenges are being time-consuming because the second phase should only be started after analysing the first phase, having potential contradictions, and the emerging nature of the qualitative phase. However, this was not a problem for a PhD study of three years. Generally, the strength of explanatory sequential design involves having a strong quantitative orientation, collecting one type of data at a time, clear delineation for readers, and a mix of emergent and fixed method. This was also felt useful for a PhD study as the data collection and analysis would be divided into two distinct phases, although the different quantitative and qualitative nature of these would require using different methods of analysis before the results could be brought together for a final interpretation. Its challenges are requiring a lengthy amount of time, the ethics approval procedure, determining significant results to focus on and explain, and designing the second phase based on the first phase, however, this was deemed to be doable within the allotted three years of PhD study.

5 The Survey

5.1 Online survey questionnaire

The first phase of the study, with the purpose of measuring perceptions of stakeholders to find about their attitudes and behaviours regarding the use of RRBMs, took place in the form of an online survey questionnaire on the Qualtrics platform. The collected data were imported later into the SPSS and NVIVO for the analysis. Sampling, designing the questions, data collection and management are explained in detail in the following section.

5.1.1 Sampling

In quantitative research, larger samples tend to be better. In order to find the minimum number of participants, online tools were used to calculate the sample size based on the expected effect size, following the factor analysis rule (DeCuir-Gunby & Schutz, 2017), and according to the discussion with statistics advisor (Table 12).

The sample in the first phase of the study is a portion of the main stakeholders relevant to the use of building materials in construction in New Zealand. It is hard to achieve a perfect sample as there is always some degree of bias or error. This can be minimized by defining the specific objectives and criteria of sampling (Fink, 2003).

Having criteria for including eligible people and excluding them based on their characteristics will help in having a better sample. A stratified sample is a method of sampling where the population of stakeholders is divided into subgroups representing the main stakeholders in the process of using RRBMs based on the literature. Then, for a valid sample, finding participants starts with lists of eligible participants who are members of each strata, and this is the sampling frame. According to the literature (see section 3.2.), the six main groups of stakeholders when it comes to the use of RRBMs, are architects and designers, builders and contractors, NGOs and environmentalists, manufacturers and suppliers of building materials) regulators and related institutes, and consumers.

Each group of stakeholders was contacted based on the available contacts from their websites or institutes, except for the consumer group where simple random sampling was used. The general rule for these types of studies is finding a larger sample size so that the results will be more accurate

and reliable, although budget and time are limitations. Because participants are divided into six groups, the diversity in each group is reduced and reaching the saturation point is easier (R. Kumar, 2005). However, the size of the sample is only one of the factors that make a good sample (Fink, 2003). After finding the websites of institutes and companies, and through use of social media and email addresses, potential participants were asked to identify other members of the population who could be in that subgroup, which is a snowball sampling technique. This technique can be used to make the sample bigger in case this is needed. Invitations were sent to every email address found through websites or social media for each group of stakeholders. However, a number of email addresses were not correct. As it can be seen in Table 12, the number of respondents in each group of stakeholders and in total is more than the expected number for the sample size.

Table 12. Sample size assumptions

Stakeholders	Population	Calculated sample size	actual sample size
Architects and designers	3000 (all New Zealand)	64	159
Builders and contractors	24000 (all New Zealand)	64	160
Manufacturers, suppliers and salvage companies	38 (finding 2 participants from each manufacturer)	40-50	103
NGOs and environmentalists	24 (finding 2 participants from each NGO)	25-30	52
Regulators	10 (finding 2 participants from each organization)	15-20	48
Consumers	Auckland city: 1,415,550 Wellington city: 190,959 Christchurch city: 341,469	64	144

For each group of stakeholders there was a specific approach to finding respondents.

- Regulators related to construction and recycling are government ministries, city councils, and related institutes such as BRANZ who help to publish guidance and regulations and their contacts were found from their websites.
- Manufacturers were selected from industry publications and internet web pages. Suppliers and demolition or salvage companies who sell building materials and components were also included in the manufacturers group, so the study deals with both new and second hand products.
- NGOs were selected based on their environmental activities that could improve the market for recycled building materials, and their contacts were found from their websites. This

group was one of the hardest to find participants for because there is little environmental activism in this area.

- Architects were selected from the New Zealand Institute of Architects and registered architects' websites. Designers' contact information was taken from architectural firms' websites as well.
- Builders were selected from the Licensed Building Practitioners Board and New Zealand Certified Builders website.
- Consumers were chosen randomly from people who lived in the target cities through social media websites like Neighbourly.

The three cities of Auckland, Wellington and Christchurch are the three largest cities in New Zealand, so the number of clean fills, landfills (Tonkin & Taylor Ltd, 2014b), population (Statistics New Zealand, 2013), the share of national GDP, and total waste products are higher compared to other cities (Tonkin & Taylor Ltd, 2014b). The Table 12 indicates how much the sample is representative of the main population, however, based on the criteria given above for finding respondents, the sample in this study is a little different from the census and construction industry population.

5.1.2 Data collection

The survey instrument is an online tool (Qualtrics) that has advantages such as requiring less time and cost but also disadvantages such as problems recruiting older respondents (Kurusu, 2015).

In order to increase the number of responses, follow-up emails were sent three times at intervals and on different dates in terms of holidays or working days. Also, gift vouchers and coffee vouchers as incentives were given to selected respondents by a draw after the survey, and a poster (see the Appendix 3) were attached to emails to catch attention of the recipient, as other methods of increasing the response rate. Identifying a large number of eligible respondents, being an anonymous survey, having realistic criteria for filtering eligible people, writing readable and understandable questions for all of the participant groups were all considered in designing the survey as these can also influence the response rate (Fink, 2003).

This phase of the research as an anonymous online survey questionnaire was approved by the Victoria University of Wellington Human Ethics Committee (approval 25492) (see Appendix 5).

5.1.3 The Questionnaire

5.1.3.1 *Design of the questionnaire*

The objective of the questionnaire was to ask stakeholders about their roles, expectations, interrelationships, and demands relevant to using RRBMs. Questions have been selected from the existing literature and reworded as necessary or designed by the author based on this objective. Straightforward questions lead to more accurate and consistent information. Respondents should be able to identify the relationship between the purposes of the survey and each question. In order to analyse the results statistically, and make them reliable and consistent, in surveys closed questions are used because they are also easier to answer. However, open questions can also help to find other possible answers which are not included in the choices (Fink, 2003). In Table 13, type of questions and the reason of designing the questions are indicated.

5.1.3.2 *Pilot Study*

Pre-testing the appropriateness of survey design is indispensable and yet has been discussed in the literature more in theory than practice. Before launching the survey to collect data, a pre-testing or pilot study can be undertaken to identify different possible problems on similar population. Issues that may arise in such a pilot study include respondents having difficulty in understanding or interpreting questions or missing the intended meaning or reference with the way questions are stated (R. Kumar, 2005). Wording and ordering the questions and procedural issues all matter in the communication to respondents.

It is also important to experiment with analysis of the data collected in a pilot study; it means that dummy tables can be prepare for expected results. Another useful test is to write up the results of the pilot study. However, it is inadvisable to place too much weight on these initial results, as the number of respondents may not be statistically relevant or they might not be good representative of the target population. Nevertheless, some differences may appear. These interpretations can help in rephrasing or eliminating the questions (Oppenheim, 1992). There are inconsistencies among these methods for evaluating a pilot study, so we should find which method is appropriate for a specific circumstance and purpose. If problematic items are seeking to shed light on underlying

theoretical domains it is important that they be retained (Rattray & Jones, 2007). Researchers should look to examine the data collected from the pilot study in the same manner of the main survey; accordingly, raw data should be prepared as an initial step, including editing and coding (Srinivasan & Lohith, 2017).

Some studies recommend between 12-50 cases as a sufficient sample size to discover flaws in the survey depending on the study (Presser et al., 2004). Other studies suggest 12 as the minimum sufficient number per group or 10% of the expected sample size, as a general rule (Johanson & Brooks, 2010). This pilot study collected responses from 27 people, which coincidentally is 10% of the expected total sample size of 270 participants. While this sample was limited to a particular demographic – students in the Victoria University postgraduate student body – this group could more readily provide constructive feedback on the questionnaire and survey process when asked. One of the other reasons behind choosing this sample of postgrad students was that they were all experienced architects or civil engineers, so they can be partly representative of the target population. It was also expected that this demographic group would have a relatively high response rate (77% in this study), enabling a more effective pilot study. The average duration for answering this online questionnaire was 23 minutes.

In this pilot study, 12 men and 15 women participated. Most of the respondents (21) claimed that their occupation was not related to RRBMs, while 11 respondents had related occupations (they chose one of the occupations in the list like architect). This suggests that many people will be unaware of the direct role they play in promoting the use of materials in the building process.

The primary purpose of the pilot study was to check the effectiveness of the methods, not only for collecting data but also for analysing it. To test whether the questions measured what they were meant to measure, the results were evaluated to check if they were meaningful and indicated any patterns that aligned with contemporary literature in the field. In the process, several changes were made to the wording and type of questions before the main survey was conducted.

The pilot survey responses indicated that respondents were concerned about environmental issues and having a sustainable building construction sector. However, when it came to the use of RRBMs, they were not familiar with current policies. From the literature the government emerged as having a leading role to play. This was also confirmed in the results of the pilot study but it was less clear whether the respondents were aware of relevant regulations and certification regimes around the use of recycled materials. In terms of the influence of environmental communities, it seemed that they did not promote RRBMs and were still in the early stages of promoting the reduction of general

waste. The architect is the stakeholder who has the responsibility of specifying materials and interpreting clients' needs and expectations in the design of a project and can therefore play an important role. This was also confirmed by the results of this study. Most of the respondents thought they did not have a role to boost the use of RRBMs, but when they were asked in detail, they understood that they could have a role, both personally and professionally.

A full explanation of the pilot study can be found in the published paper (Balador, Gjerde, & Isaacs 2018).

5.1.3.3 Questions

After clear identification of the research questions and assumptions, survey items can be formulated based on the literature. Linking concepts with questions underlies the validity of the questionnaire, and different techniques in designing questions have been used in order to increase validity. Potential threats to validity could come from the embarrassment of not having an opinion or social desirability, for instance, people answer the question to show that they have an opinion that complies with social norms not their real opinion. These threats can be reduced by assuring participants the survey is anonymous. Also, in order to improve the accuracy of the questionnaire, it is better only to ask about respondents' own behaviour and opinions, and not those of other stakeholders. Putting the "no opinion" option is another way to make choices more explicit. Asking open-ended questions along with closed-ended ones can also provide a higher degree of validity. A 5-point scale is a safe way to collect information on attitudes and opinions, and multiple-choice questions are also easy to answer.

There are fourteen sections in the developed questionnaire. Demographic questions are necessary to compare groups and check the representativeness of the sample and for comparisons with other studies. Since these are an important part of the analysis, they come first. Then, in order to monitor differences between stakeholders, there is a question asking about occupation. Items are presented in a logical flow according to the purpose of the question. The main categories in the first part of the questionnaire are classifying respondents based on their demographics, their environmental attitudes, and their knowledge about environmental issues. The second part is focused on their perceptions and understanding about RRBMs; their experience of using these materials; and finally, their knowledge about their role in this area and others' roles. The reason for each question based

on the literature are explained in Table 13. Double-barrelled questions, double negatives, repetitiveness, and leading and biased questions have been avoided in the design of the questions.

Table 13. Questions and reasons

Demographics	
1.	What gender do you identify with? (multiple choice) <ul style="list-style-type: none"> ○ Male ○ Female ○ Other
2.	Which of the following age bracket do you fall under? (open-ended) <ul style="list-style-type: none"> ○ 18-29 years old ○ 30-49 years old ○ 50-64 years old ○ 65 years and over
3.	What is the highest level of education you have completed? (multiple choice) <ul style="list-style-type: none"> ○ Secondary school (college) ○ Trade/technical/vocational training ○ Bachelor's degree ○ Postgraduate degree ○ None of the above
4.	Which income bracket best describes your annual income before taxes? (multiple choice) <ul style="list-style-type: none"> ○ Less than \$19,999 ○ \$20,000 to \$39,999 ○ \$40,000 to \$79,999 ○ \$80,000 to \$109,999 ○ \$110,000 or more
5.	Including yourself, how many people live within your household? (multiple choice) <ul style="list-style-type: none"> ○ 1 ○ 2 - 3 ○ 4 - 5 ○ 5 or more
6.	In which city do you live? (open-ended)
7.	Are you a homeowner? (Please tick one). (dichotomous- Yes/No)
Reason for questions	
<p>A number of factors, such as demographics, can affect the result of environmental attitudes and pro-environmental behaviours (Dunlap et al., 2000; Hawcroft & Milfont, 2010; Hur et al., 2015). Comparison of results based on sociodemographic categories have revealed changing attitudes to environmental issues. For example, Thomson (2008) and Steel et al. (2005) found that respondents with higher levels of education also score higher for environmental attitudes.</p> <p>Oskamp et al (1991) investigated the influence of dwelling ownership on environmental concerns. Based on the household situation and type of residence there are different opportunities and obstacles to behaving environmentally (Davies et al., 2002; Klöckner, 2013)</p>	
Occupation	
8.	Is your occupation related to reclaimed or recycled building materials? (Please tick one). (dichotomous- Yes/No)
9.	What is your occupation? (Please tick one). (multiple choice) <ul style="list-style-type: none"> ○ Building material manufacturing or salvage/ resale industry ○ Builder, or working for a builder ○ Architect or working in an architectural firm ○ Environmental activist or working in an environmental NGO ○ In government or institutes related to building or environmental regulations ○ None of the above, please specify
Reason for questions	
<p>Environmentalists and white-collar workers score higher in New Environmental/Ecological Paradigm (NEP) studies compared to lay people and blue-collar respondents (Hawcroft & Milfont, 2010).</p>	
General environmental attitudes	

<p>Please select the option that best describes your opinion for each statement. Some of the statements may appear to be similar, but they do address somewhat different issues. Please read each statement carefully. (Please tick one for each statement) (5-point Likert scale-Strongly agree/Agree/No opinion/Disagree/Strongly disagree)</p>	
10.	The balance of nature is very delicate and easily upset by human activities
11.	The earth is like a spaceship with only limited room and resources
12.	Plants and animals do not exist primarily to be used by humans
13.	Modifying the environment for human use seldom causes serious problems
14.	There are no limits to growth for nations
15.	Mankind is created to rule over the rest of nature
Reason for questions	
<p>NEP is the most widely used scale for measuring environmental attitudes as it measures the general beliefs of people and not specific environmental issues (Hawcroft & Milfont, 2010). Since having positive environmental attitudes is an important antecedent of pro-environmental behaviours, examining the environmental attitudes of people is essential for the promotion of these behaviours (Ogunbode, 2013). Besides, in more affluent countries like New Zealand, environmental actions are more influenced by morality, so can be predicted by attitudes (Thøgersen, 1994). Many studies have proved that having positive attitudes towards the environment is associated with its conservation (Klößner, 2013). In addition, most studies in this field support the TPB introduced by Ajzen in that understanding attitudes can help to explain behaviour (Begum et al., 2009).</p>	
Environment-friendly building construction attitudes	
<p>Please select the option that best describes your opinion about environmentally friendly building construction for each statement. (Do you agree that these statements are important to have an environmentally friendly building construction?) (Please tick one for each statement) (5-point Likert scale-Strongly agree/Agree/No opinion/Disagree/Strongly disagree)</p>	
16.	Building or Purchase of sustainable buildings
17.	Building or Purchase of buildings with lower carbon footprint
18.	Purchase of environment-friendly building materials
19.	Purchase of building materials locally produced
20.	Purchase of reclaimed building materials
21.	Purchase of recycled building materials
Reason for questions	
<p>In the TPB, motivation or intention is essential, and has a direct relationship with the other influential factors (Ajzen, 1991). Lack of motivation is one of the barriers to reducing waste (Chung & Poon, 1999). In the TPB, the intention is an immediate determinant that can be called a plan for the behaviour that in conjunction with other factors enables the person to act in a pro-environmental way. Intention has always been a concern for psychologists (Klößner, 2013). Questions in this section were designed to measure the intention of environment friendly behaviours in the construction sector.</p>	
Green purchase influential factors	
<p>Please select the option that best describes your opinion for each statement. (Please tick one for each statement) (5-point Likert scale-Strongly agree/Agree/No opinion/Disagree/Strongly disagree)</p>	
22.	Construction is one of the most polluting industries.
23.	People are more concerned about reuse or recycling these days.
24.	People usually buy environment-friendly products in order to feel good.
25.	Price plays an important role in buying environment-friendly building materials and products.
26.	Reclaimed and recycled building materials and products are usually available in your nearby suppliers' stores.
27.	Advertisements have an effect on people's buying behaviour of reclaimed and recycled building materials and products.
28.	Required information for deciding on reclaimed and recycled building materials and products is easily accessible.
29.	You can easily find specifications for reclaimed and recycled building materials and products.
30.	People usually decide to buy environment-friendly products based on advertisements.
31.	People normally find any reclaimed and recycled building materials and products or something similar that they want from suppliers near their living areas.
32.	People's purchase behaviour of environment-friendly products is based on price to a great extent.
33.	Buying environment-friendly products will bring self-satisfaction.
34.	Everyone has some people around who have environment-friendly behaviours.

35.	Benefits of reclaimed and recycled building materials and products are more than their drawbacks.
Reason for questions	
Bahamon (2010) states that construction is one of the most polluting industries. Klockner used Ajzen's definition for Perceived Behavioural Control (PBC) in his earlier research as "the person's belief as to how easy or difficult performance of the behaviour is likely to be". This definition can be extended to internal factors like abilities and knowledge and external factors like opportunity and the cooperation of other stakeholders that leads to a behaviour (Klößner, 2013). PBC is partly constituted of factors influencing green purchases.	
Given enough environmental information on products and eco-labelling will increase knowledge value and consequently have a positive influence on sustainable consumption behaviour adoption. To these educational drivers, economic incentives should be added, since this will encourage consumers, even the non-green segment (Biswas & Roy, 2015). Earlier research showed that price, quality and convenience are the most important factors influencing buying behaviour (Freeman, 1990; Ottman & Books, 1998). Other studies say that self-care motivations such as health and money are stronger than environmental concerns when it comes to buying green and recycling (Dursun et al., 2016). Other factors include having a higher degree of transparency (Cheng et al., 2014; Hart, 1995), and giving additional information about the benefits, performance, and quality of the environmentally friendly products (Grimmer & Bingham, 2013; Heikkurinen, 2010; Rodriguez-Melo & Mansouri, 2011; Sandhu et al., 2010; Tilikidou, 2013).	
Other influential factors for green purchase behaviour and recycling behaviour have been discussed in the literature review (see sections 3.1.1)	
Evaluations	
36.	How do you evaluate the importance of using reclaimed and recycled building materials? (Please order from 1 to 5 with the slider – 5 being the most important, 1 being the least). (Rating) <ul style="list-style-type: none"> ○ Environmental ○ Economical ○ Social
37.	If you think there is another benefit in using reclaimed or recycled building materials that is not mentioned above, please specify it here, in your own words. (open-ended)
Reason for questions	
Facilitating the drive towards environmental improvements within the construction industry involves stakeholders, who have varied and sometimes unclear roles and responsibilities when it comes to choosing materials (Sandhu et al., 2010). For evaluating environmental strategies, it is thus beneficial to consider the three components of sustainability from the stakeholders' point of view (Duran, Gogan, Artene, & Duran, 2015).	
Companies' performance	
Please select the option that best describes your opinion for each statement. (Please tick one for each statement) (5-point Likert scale-Strongly agree/Agree/No opinion/Disagree/Strongly disagree)	
38.	The public image of the company is important when buying reclaimed or recycled building materials.
39.	Producers and suppliers of reclaimed or recycled building materials know what their consumers want.
40.	The environmental image of the company is important when buying reclaimed or recycled building materials.
41.	There is a gap between environment-friendly companies' claims and performance in the construction industry.
42.	Producers and suppliers of reclaimed or recycled building materials communicate enough with people.
Reason for questions	
One of the findings of similar studies is that mere environmental concern does not necessarily lead to environmental behaviour. Considering this fact, marketing professionals should not only have green production but also pay attention to the functional, emotional, and experiential needs of society, and give enough information about their environmental performance and this matches the desirable social image and lifestyle of people (P. Kumar & Ghodeswar, 2015). The literature review identified different suggestions for marketing professionals: understanding consumers present and future lifestyles, knowing how they	

communicate with the media, and helping them have a positive image (Bendell & Kleanthous, 2008) (see section 3.1.1).	
Environmental activities	
43.	Have you ever participated in environmentally friendly activities related to reclaimed and/or recycled building materials? (Please tick one). (dichotomous- Yes/No) If yes, it goes to Q44
44.	Which environmental activities best describe your participation (present or past)? Please tick as many as you need to best describe your role. (multiple choice) <ul style="list-style-type: none"> ☐ Fundraising ☐ Creating a network ☐ Social movement ☐ Assessing environmental impacts ☐ Effective voice ☐ Others, please specify
Reason for questions	
Societal pressures which influence stakeholders' performance can be derived from environmental NGOs as well as families, friends and colleagues. Having a more resourceful approach to waste requires actions from communities (Community Recycling Network, 2017; NZAIA, 2016; Sandhu et al., 2010) (see section 3.2.1)	
Regulations	
Please select the option that best describes your opinion for each statement. (5-point Likert scale-Strongly agree/Agree/No opinion/Disagree/Strongly disagree)	
45.	There are enough regulations related to reclaimed and recycled building materials.
46.	You have knowledge about regulations related to the use of reclaimed and/or recycled products in building construction process.
47.	There are enough building certificates related to reclaimed and recycled building materials.
48.	There are enough building material certificates related to reclaimed and recycled building materials.
Reason for questions	
The government can, and it has been argued ought to, be a leader in any sustainable transition in society by acting as a facilitator, stimulator, controller, and director. National, local and regional governments all have roles depending on the type of change and their closeness to other actors. However, there are always external factors, political structure, and socio-cultural factors that influence this role (Rotmans et al. 2001). The increasing use of regulations is an encouraging force behind the improved environmental performance of buildings (Guoyou, Saixing, Chiming, Haitao, & Hailiang, 2013; Paulraj, 2009). In different countries, related policies proposed by governments have the goal of reducing the extraction of new materials and reducing materials going to landfills. However, an influential factor apart from existing regulations is people's awareness of these regulations.	
Material specifications	
49.	How do you evaluate the importance of specifications of building materials (When purchasing reclaimed and recycled building materials)? (Please order from 1 to 5 with the slider – 5 being the most important, 1 being the least). <ul style="list-style-type: none"> ☐ Health ☐ Durability ☐ Cost ☐ Quality and performance ☐ Environmental impacts ☐ Safety ☐ Others, please specify
Reason for questions	
Dursun et al's (2016) study showed that a negative economic influence was not significant but the positive influence of personal health and the environment was for green buying behaviour. Also, quality of life, health, and safety are the most important factors in buying natural, organic and recycled products. On the other hand, for simple buying behaviour the economic factor was significant. Earlier research showed that price, quality and convenience were the most important factors influencing buying behaviour (Freeman, 1990; Ottman & Books, 1998). BRANZ in New Zealand has given a guide to choosing materials wisely by weighing up many issues and these factors have been taken from this guide (Conder, 2008)	
Environment-friendly behaviours	

50. Please select any practice in the following list that you participate in. Please tick as many as you need to best describe your role. (list)

- ☐ Recycling paper, plastic, glass bottles, cardboard, aluminium cans, or other products
- ☐ Repairing items as much as possible
- ☐ Reuse different products
- ☐ Reduction of waste generation
- ☐ Selection of products based on carbon footprint
- ☐ Buying energy-efficient products
- ☐ Purchase of environment-friendly products
- ☐ Buying recycled products
- ☐ Buying items from the flea market
- ☐ Purchase or build energy-efficient buildings
- ☐ Purchase or build sustainable buildings
- ☐ Purchase or build buildings with lower carbon footprint
- ☐ Purchase of environment-friendly building materials
- ☐ Purchase of building materials locally produced
- ☐ Purchase of building materials with lower carbon footprint
- ☐ Purchase of reclaimed building materials
- ☐ Purchase of recycled building materials

Reason for questions

There are different frameworks proposed by different countries for measuring pro-environmental behaviours, that include, reuse, recycling, green purchase and waste minimization, and the main targets are standard in many places (Kurusu, 2015). These items have been chosen from different frameworks given in Kurusu's book that relate to the purpose of the study.

Stakeholders' roles

Please answer each of the following questions by selecting the option that best describes your opinion. (please tick one) (rating- choosing among Consumer/ Manufacturers and Salvage Industry/ Architects/ Regulators/ NGOs and Environmentalists/ Builders)

51. Who has a more important role in enhancing reuse and recycling of building materials?

52. Who do you think plays the most significant role in changing attitudes for reuse and recycling of building materials?

53. Who has the most significant role in implementing the use of recycled building materials in the industry?

54. Who has a more important role in checking the safety and performance of reclaimed and recycled building materials in the building construction process?

55. Who do you believe has a more important role in consumers' ideas of using reclaimed and recycled building materials in buildings?

56. Do you have a role in enhancing reuse and recycling of building materials? (Dichotomous- Yes/No) (If yes, it goes to Q57)

57. What is your role in enhancing reuse and recycling of building materials? Please specify in your words. (open-ended)

Please answer each of the following questions by selecting one option. (Dichotomous- Yes/No)

58. Do you know other stakeholders' roles in the market of reclaimed and recycled building materials?

59. Do you have knowledge about related regulations to reuse and recycling of building materials which is related to your occupation?

60. Do you have an occupation that has an effect on increasing the use of reclaimed and recycled building materials?

61. Should you agree with using reclaimed and recycled building materials according to your professional responsibilities?

62. Would you suggest to others use of reclaimed and recycled building materials?

Reasons for questions

Identifying the more effective driving forces behind these approaches and improvements can be a fraught exercise. However, To create a multidimensional sustainable approach, it is necessary to also consider the responsibilities and perceptions of different stakeholders (Sandhu et al., 2010). Questions in this section were designed to discover the awareness of stakeholders about each other's roles (see section 3.2.1). Demand for reused waste products is strongly dependent on government policies as well as the personal and professional preferences of building clients, contractors, developers and other client groups (Addis, 2012).

Bahamon (2010) states construction is one of the most polluting industries and as architects are an important stakeholder group in the construction industry, they are prime candidates for changing attitudes towards recycling. There is an assumption that by increasing awareness about benefits clients will be more willing to use RRBMs. In a situation where there is still no defined or proposed legal requirement, the interest and ideas of the design team and the client could provide significant impetus for action (Addis, 2012).

Communities are a driving force along with non-governmental organizations (NGOs) who pay attention to environmental issues and have a direct or indirect influence on firms through changing public attitudes, and persuading consumers by publicizing information. Therefore, firms can benefit from having relationships with communities (Guoyou et al., 2013). Driessen & Hillebrand (2013) concluded that green issues are mostly considered by nonmarket stakeholders so that organisations should be aware of these issues as they are important.

Due to the nature of the professions, some corporations have a better opportunity to serve the society with appropriate technology and respect for human well-being (Vitell, 2014). Building material manufacturers are one of these (Smith, 2004). Also, industry-wide regulations have been effective in increasing the responsiveness of organizations to environmental issues (Sandhu et al., 2010)

Problems

63. Is there anything else you feel is relevant to this study? (open-ended)
Were there any specific items in the questionnaire that you found difficult to answer? If yes, please identify them and explain why.
Thank you for taking the time to complete this questionnaire.

Focus group participation

64. If you are willing to participate further in this research by taking part in a focus group, please click yes. This will take you to another page with a link, then click the link to enter your contact information. This will help us finalize the results of this survey based on your insight about its findings. (Dichotomous-Yes/No)
(if you give your contact information you will be included in a prize draw, and you will receive information on the conclusions of the research)

5.1.3.3.1 Data management

The online questionnaire was distributed from January 2018 and ended in May 2018. When all questionnaires were received, the data management started with data entry. Computer-assisted data collection has changed data management since most of the steps are done in the data collection itself (Groves et al., 2011). Qualtrics as an online platform was used for data collection and the data was exported to SPSS for analysis. SPSS is a statistical program that provides automatic data entry. There are two types of data based on the question type, these being numeric and text answers.

Prior to data analysis, data should be cleaned in terms of range, ratio, and consistency. Checking for missing data and deciding about statistical techniques to compensate for this is part of this process. In cases where one person has only one item of deleted or missing data, this has been substituted with the mean value of the group. But if a person has stopped answering the questionnaire at a particular point, or has not answered a series of questions, the answers have

been left as they are. This means for some questions, the total number of respondents is different (Sue & Ritter, 2011).

After data cleaning, the data transformation takes place. Some data had to be altered for calculating the score of the question. For example, the score of negative statements of the NEP scale should be reversed and recoded, and the raw data of the question asking about the city should be converted to numbers (Sue & Ritter, 2011). Open-ended questions should also be coded. Some text answers from open-ended questions were imported to NVivo for the analysis. NVivo is a qualitative data analysis computer software package and is useful for working with large amounts of text-based data.

The type of question and hypotheses defines the statistical tests to be used for data analysis. The number and type of variables and type of scale should also be considered. Before each statistical analysis, the relevant assumptions must be made (Creswell & Clark, 2007). The detailed procedure of the analysis is explained in chapter 6.

6 The survey results

6.1 Survey Questionnaire

6.1.1 Sample characteristics

Descriptive statistics show there were 666 participants, with more men (65%, n=432) than women (35%, n=234). As the majority of respondents had an occupation related to the construction industry, this tends to align with the general distribution of gender in the construction sector. For example, based on the NZIA statistics, 20% of all Registered Architects and NZIA Fellows are female (NZIA, 2018). In this study, 34% of architects are women, so the sample is over-represented in terms of having more women than the main population group.

Most respondents (50%, n = 329) were aged 30 and 49 years, followed by 50–64 (28%, n = 188), 18–29 (13%, n = 87), and 65 and over (9%, n = 62). This distribution was expected based on the occupations who took part. Based on the New Zealand education levels, 32% of participants had completed a postgraduate degree (n = 212), followed closely by trade/technical/vocational training (30%, n = 197), bachelor's degree (30%, n = 197), secondary school (college) (7%, n = 48), with 2% of respondents choosing the “none of the above” option that could indicate no formal qualifications (n = 12). Most respondents had an income in the range of \$40,000 to \$79,999 (33%, n=218), followed by \$110,000 or more (29%, n=191), \$80,000 to \$109,999 (22%, n=144), \$20,000 to \$39,999 (10%, n=64), and less than \$19,999 (7%, n=48). Most respondent households were 2-3 people (55%, n=361), followed by 4-5 people (31%, n=206), 1 person (8%, n=55), and 5 or more (7%, n=44). Additionally, most were from Auckland (43%, n=287), followed by Wellington (35%, n=234), and Christchurch (22%, n=145). Ownership of the dwelling was investigated as an influential factor in the use of recycled materials in similar studies. The majority of respondents owned their dwelling (70%, n=467).

The demographic data were compared to Statistics New Zealand Census 2013 data to determine the representativeness of the study sample. It is not possible to claim the sample is truly representative of the whole population of the three cities (Table 14). For example, men are under- and women are over-represented; age distribution is close to that of the main population; education level in terms of secondary school qualifications, vocational training and no qualifications is under-represented, and bachelor's degree and postgraduates are over-represented. However, the

comparison with the demographics of the construction industry is closer in terms of trends, with the exception of education where, as expected, there are many more people with trade qualifications. The income level is also close to the mean value for the building construction industry for the years 2008 to 2018 (Figure NZ, 2018). The mean value for 2018, the date of the survey, was NZ\$64,640 (Table 14).

Table 14. Descriptive statistics of sociodemographic data

Characteristics	n	Valid		
		Survey sample	Census (2013)	Construction industry (2013)
Gender				
Men	432	65%	49% [1]	83% [2]
Women	234	35%	51%	17%
Age				
18-29 years old	87	13%	16% [1]	22% [3]
30-49 years old	329	49%	26%	52%
50-64 years old	188	28%	19%	26%
65 years and over	62	9%	14%	4%
Education				
Secondary school (college)	48	7%	16% [1]	8% [4]
Trade/technical/vocational training	197	30%	43%	69%
Bachelor’s degree	197	30%	13.6%	6%
Postgraduate degree	212	32%	6%	2%
None of the above	12	2%	21%	11.7%
Income				
Less than \$19,999	48	7%	38% [1]	N/A
\$20,000 to \$39,999	64	10%	26%	
\$40,000 to \$79,999	218	33%	22%	
\$80,000 to \$109,999	144	22%	8%	
\$110,000 or more	191	29%	6%	
Number of people in the house				
1 person	55	8%	N/A	N/A
2-3 people	361	54%		
4-5 people	206	31%		
5 or more	44	7%		
City				
Auckland	287	43%	32% [5]	29% [6]
Wellington	234	35%	12%	3%
Christchurch	145	22%	11%	13%
Dwelling ownership				
Yes	467	70%	N/A	N/A
No	199	30%		
total	666	100%		

[1]. Statistics New Zealand, Census, from www.stats.govt.nz, 2013.

[2]. "Snapshot of Women in Construction", from www.bcito.org.nz, 2013.

[3]. "Age distribution of people working in the building construction industry in New Zealand", Figure NZ, from www.figure.nz, 2013.

[4]. Figure NZ (2013). "Highest qualifications of people working in the building construction industry in New Zealand", from www.figure.nz, 2013.

[5]. "People employed in the construction industry in New Zealand", Figure NZ, from www.figure.nz, 2013.

[6]. "New Zealand population by region", Figure NZ, from www.figure.nz, 2013.

6.1.2 Stakeholder groups

The results indicate that the majority of respondents, 280 out of 666, (58%) believe their occupation is not related to RRBMs. Question 9 asked about occupation and the answers to this question have been divided into the six groups of stakeholders (Table 15). The sixth survey group which is the consumer group all chose the “None of the above” option, which was to be expected as their occupations had nothing to do with building materials.

Table 15. Frequency of each stakeholder group

Stakeholder groups	Frequency	Valid
In a building material manufacturing or salvage/ resale market or sellers of building materials	103	15%
Building practitioner, or working for a builder or a contractor	160	24%
Architect, designer, or working in an architectural firm	159	24%
Environmental activist or working in an environmental NGO or community	52	8%
In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	48	7%
None of the above, please specify	144	22%
Total	666	100.0

6.2 NEP scale

The environmental attitudes of the whole population were checked in the first stage of the analysis. Figure 14 gives the descriptive characteristics of respondents’ scores on the NEP scale. This shows the environmental views of participants were generally positive, being above the medium level of 3 points. The most positive attitude was achieved by item 1, which is “The balance of nature is very delicate and easily upset by human activities “ (mean=4.47), following by item 2 “The earth is like a spaceship with only limited room and resources “ (mean=4.46), item 3 “Plants and animals do not exist primarily to be used by humans “ (mean=4.35), item 6 “Mankind is created to rule over the rest of nature” (mean=4.23), item 5 “There are no limits to growth for nations” (mean=4.14), and item 4 “Modifying the environment for human use seldom causes serious problems” (mean=3.93). Using the comments from respondents in the pilot study, suggested some reasons behind the differences in these scores. Positive items usually gain higher scores since comprehending them is easier and faster for respondents, especially in long questionnaires that they are in a hurry to complete. This issue is most evident in item 4 with the lowest score, as it has a negative adverb in

its phrasing that some may have conceived as a positive statement. Also, the wording of this item with “serious” may have made respondents doubtful and therefore unable to show a positive response confidently. However, item 6 has the highest “strongly agree” score (63.3%), closely following by item 3 (62.1%), 2 (61.5%) and 1 (59.4%).

Figure 14. Descriptive statistics of respondents in NEP scale

Cronbach's alpha simply provides an overall reliability coefficient for a set of variables. Internal consistency can be evaluated by means of Cronbach's alpha and the lowest acceptable range is around 0.60, based on different studies, however a range between 0.70 and 0.80 shows high internal consistency (Ogunbode, 2013; Reyna, Bressán, Mola, Belaus, & Ortiz, 2018). Measuring the consistency of this scale shows Cronbach alpha was 0.667 (Table 16), which was higher than the consistency of Thomson's study (for the Versus Research institute) which was between 0.422-0.626 in different years (Versus Research Ltd, 2013). Also, another study by Lovelock (2010) had a Cronbach's α as low as 0.693 for measuring the environmental attitudes which was acceptable (Lovelock, 2010). However, the reliability of the current measurement tools proved to be high for this specific sample compared to similar studies. The removal of any question would result in a lower Cronbach's alpha, so it was desirable that no item was removed (Table 16).

Table 16. The consistency of the NEP scale

Cronbach's Alpha if Item Deleted						Cronbach's Alpha
1	2	3	4	5	6	Total
.639	.620	.601	.628	.628	.570	.667

Validity for the scale can be proved by expected results. Based on a meta-analysis by Hawcroft and Milfont (2010), environmentalists should score higher than others, and white-collar workers more than blue-collar workers as education should have a positive effect on environmental attitudes. Also, a 6-item scale usually gets a higher score than a 12 or 15-item scale (Hawcroft & Milfont, 2010). All of these factors were supported by the results. Comparison of the results of the different stakeholder groups and analysing the influence of socio-demographic data showed these differences, and this supports the validity of the questionnaire (see section 6.2.1, 6.2.2.).

To compare this study with one prepared for the Waikato Regional Council, scores have been placed into the three categories of anti-ecological, mid-ecological, and pro-ecological (Figure 15). In order to convert scores into these categories, the average score was multiplied by 6 so the maximum possible score would be 30. In other words, pro-ecological is equivalent to a score of 79 to 100% or one in the 25-30 range, mid-ecological is equivalent to a score of 54 to 78% or one in the 19-24 range, and anti-ecological is equivalent to a score of 50% or less or one in the range of 6-18. As in Thomson's (2013) study (for the Versus Research institute), overall respondents agreed with pro-ecological statements.

Figure 15. The 6-item NEP scale scores in the allocated categories

In 2000 the NEP scale was used as part of the Waikato Regional Council's Environmental Awareness, Attitude and Actions Survey, and for further studies in 2004, 2008, 2013 and 2016 the NEP statements were used in the New Ecological Paradigm Survey by Versus Research Ltd commissioned by Waikato Regional Council (Versus Research Ltd, 2013, 2016).

Figure 16 indicates the percentages of people in this study who had NEP scores on the scale of 6 to 30. The majority of respondents sit in the pro-ecological range, while in the previous studies for the Waikato Regional Council the majority were in the mid-ecological range, although, the target audience was different. The current research has targeted people in the three cities of Wellington, Auckland and Christchurch and specifically targeted stakeholders related to RRBMs, including a group of consumers.

Year on year results for 2000, 2004, 2008, 2013, and 2016 for the Waikato regional Council indicate a growth in the pro-ecological portion and a decrease in the anti-ecological portion (Versus Research Ltd, 2013, 2016). While the different demographic characteristics of the sample populations may not allow for direct comparisons, this trend toward pro-environmental attitudes can be helpful in understanding the results of this study (the data collection of this study was carried out in Jan 2018).

Figure 16. Per cent of people giving each score

Themes have also been grouped based on the Albrecht dimension categorisation (see section 3.1.2) (Albrecht, Bultena, Hoiberg, & Nowak, 1982). “Balance of Nature” as an underlying belief appears to be the most pro-ecological tendency with 92% agreement (M=4.47), the next driver is “limits to growth” with 84.15% agreement (M=4.30), then “man over nature” has 79.13 % agreement (M=4.17) (Figure 17). Thomson’s study (2008) for the Waikato regional council showed that “limits of growth” had a higher score (3.77) followed by “balance of nature” (3.67) and “man over nature” (3.53) (Thomson & Versus Research Ltd, 2008). Comparing themes between this study and Thomson’s indicated that scores were lower in the Thomson study and the order of themes was different. In Dunlap et al.’s (2000) earlier US study, the order of the themes is the same with 85% in “balance of nature”, 73% in “limits of growth” and 64% in “man over nature”. Figure 17 presents

the results of the Albrecht categorisation for this study compared to Dunlap's and Thomson's studies.

Figure 17. Ecological view point themes, based on the percentage of people who "agree" or "strongly agree" with the theme

Looking more deeply into these ecological beliefs could reveal the different motivations behind the opinions people expressed. For example, some people may have responded positively to the statement that nature is a valuable resource for human beings because they need it to exploit it in their business activities. While many are supportive of conserving the environment, when it comes to increasing regulations and societal compulsion to do so, their attitudes seem to change. They appear to trust in those who set these regulations while also being blissfully unaware of their own impacts, or the combination of everybody's impact. Thomson also found that people seem to accept that human use may cause problems in the environment, but may also consider these problems are exaggerated because they do not have sufficient knowledge of them (Versus Research Ltd, 2013).

6.2.1 Effect of socio-demographic differences

In this study, respondents answered the NEP questions before any other questions seeking opinions, so this part can be treated as a stand-alone survey. A comparison of the results based on the sociodemographic categories should reveal any difference in attitudes to environmental issues. As Dunlap et al. (2000) noted in their study, a number of factors, such as demographics, can affect environmental attitudes, and various studies have been conducted to find these relationships. However, there are inconsistencies among these, which could be due to the time and social situation (Kurusu, 2015). Despite sociodemographic and time differences, it is useful to compare the results

of this study with other sample population in New Zealand, such as the studies for the Waikato Regional Council.

Table 17. T-test results of the environmental attitudes of respondents based on their socio-demographics

Variable	Group	M	SD	t/F
Gender	Men	4.23	0.62	-1.816
	Women	4.33	0.69	
Age	18-29 years old	4.20	0.70	0.491
	30-49 years old	4.25	0.65	
	50-64 years old	4.29	0.60	
	65 years and over	4.31	0.69	
Education	Secondary school (college)	4.04	0.76	4.390
	Trade/technical/vocational training	4.20	0.63	
	Bachelor's degree			
	Postgraduate degree	4.38	0.61	
	None of the above	4.28	0.64	
Income		3.97	0.72	1.320
	Less than \$19,999	4.14	0.70	
	\$20,000 to \$39,999	4.18	0.76	
	\$40,000 to \$79,999	4.32	0.65	
	\$80,000 to \$109,999	4.28	0.62	
City	\$110,000 or more	4.23	0.60	2.702
	Auckland	4.20	0.67	
	Wellington	4.30	0.61	
	Christchurch	4.34	0.64	
Ownership	Yes	4.30	0.62	2.749
	No	4.16	0.69	

Table 17 compares the mean scores for the NEP scale according to the sociodemographic data. The mean scores show the average of points from the 5-point Likert scale NEP questions. As the scale items were coded from 1 = “strongly disagree” to 5 = “strongly agree”, each person has an average score based on these points. The results of the t-test carried out to compare the two groups of men and women indicated that there was no statistically significant difference in the scores of environmental attitudes for men ($M=4.23$, $SD=0.62$) and women ($M=4.33$, $SD=0.69$), $t(660) = -1.816$, $p = 0.070$. A one-way ANOVA was conducted to compare the effect of age, education level, city of residence, and income on environmental attitudes. There was no significant effect for age, city, and income on environmental attitudes at the $p<.05$ level for the four age ranges and five income ranges, $[F(3, 658) = 0.491, p = 0.689]$, $[F(2, 659) = 2.702, p = 0.068]$ and $[F(4, 656) = 1.320, p = 0.261]$ respectively.

Figure 18. Mean NEP scores according to education level

Education levels were found to have a significant effect on environmental attitudes at the $p < .05$ level for the five education levels, $[F(4, 657) = 4.390, p = 0.002]$. A Tukey post hoc test revealed that the environmental attitudes score was statistically significantly lower in secondary school ($4.04 \pm 0.76, p = .008$) and in trade/technical/vocational training ($4.2 \pm 0.63, p = .035$) compared to those with a bachelor's degree (4.4 ± 0.61) (Figure 18). There was no statistically significant difference for the other education levels. The high mean score for the "none of the above" option that probably shows they do not have formal qualifications was based on a sample too small to be statistically comparable with the other groups ($n=12$). To compare two groups of people based on their ownership of a dwelling another t-test carried out. Results indicated that there was a statistically significant difference in the scores of environmental attitudes for owners ($M=4.31, SD=0.62$) and non-owners ($M=4.16, SD=0.69$), $t(660) = 2.749, p = 0.032$, meaning the former were more positive in their environmental attitudes. Oskamp (1991) found the same result when he investigated this variable.

Comparing the mean scores of respondents showed that socio-demographic classifications did not have an influence on their environmental orientations but that education and ownership of property had some influence. Taken together, these results suggest that education has a positive impact on the ecological worldviews of the respondents. Specifically, those with a bachelor's degree scored higher, but not significantly higher than those with a postgraduate degree, and both have relatively higher score as seen in Figure 19. As the "none of the above" group is a very small, relevant comparisons cannot be made.

Comparing education and the NEP scores with other studies offers more insight into the issue that the NEP score is positively related to education (Dunlap et al., 2000; Hawcroft & Milfont, 2010). Thomson (2008) and Steel et al. (2005) also found that respondents with higher levels of education scored higher. Cottrell (2003) reviewed other studies, and found that as education increases, environmental knowledge and subsequent behaviour improves (Cottrell, 2003).

Figure 19. Allocated categories of NEP score to each education level

6.2.2 Effect of Occupation

A one-way ANOVA was conducted to compare the effect of occupation on environmental attitudes. There was a significant difference at the $p < .05$ level for the six groups, $[F(5, 656) = 3.739, p = 0.002]$. A Tukey post hoc test revealed the environmental attitudes scores were statistically significantly lower for the manufacturers and suppliers group ($4.11 \pm 0.72, p = .001$) and the builders and contractors group ($4.22 \pm 0.64, p = .024$) compared to the environmentalists group (4.54 ± 0.57) (Figure 20).

The fact that the environmentalist group has a higher NEP score compared to the other groups of stakeholders is not surprising since their occupation requires this sensitivity. Figure 20 also shows this finding is consistent with the fact environmentalists and white-collar workers score higher in NEP studies compared to lay people and blue-collar respondents (Hawcroft & Milfont, 2010).

Figure 20. Mean NEP scores according to occupation

6.2.3 Conclusion

To succeed in the creation of a sustainable building construction approach, a better understanding of sector stakeholders' ecological worldviews would be beneficial. This section presents the analysis of the environmental attitudes of the different stakeholder groups related to the use of RRBMs in building construction processes in Auckland, Wellington and Christchurch. Comparing the results based on the sociodemographic data and occupations reveals some significant differences and makes for a useful comparison with the results of earlier studies in both New Zealand and internationally.

There are differences in environmental attitudes for the groups according to education level and ownership of their dwelling. Allocating mean scores into pro-ecological, mid-ecological, and anti-ecological themes shows that overall respondents had pro-ecological attitudes in this study, while in earlier studies mean scores sit in the mid-ecological level. Comparison by date of the study reveals that pro-ecological attitudes have increased, and anti-ecological attitudes have decreased. Statistical analysis shows that occupations have a significant effect on environmental attitudes. Of the groups who are not associated with environmental activism, the architect/designer group had higher mean scores than other stakeholder groups, including consumers. The main findings of this section are consistent with earlier NEP studies, in terms of the sociodemographic influences.

6.3 Theory of Planned Behaviour

TPB is a commonly used model in the prediction of environmental behaviour, and in this study, is used to predict the behaviour of using RRBMs. Its main determinants are attitude, subjective norm, perceived behavioural control, and intention. Full descriptions of all determinants have been given in literature review chapter (section 3.1.3) and only a short summary is given here. In the TPB, intention is essential, and has a direct relationship with the three other factors (Ajzen, 1991). Based on the findings of other studies supporting the TPB, these three factors normally have an influence on behaviour via intention, but can also have some direct influence (Li et al., 2015). Items were measured using a five-point Likert scale and were coded from 1 = “strongly disagree” to 5 = “strongly agree”. Mean scores for each component were calculated based on these points.

Behaviour (Beh): The behaviour of designers in reducing construction waste can be measured by asking them about this (Li et al., 2015), and in this study this has relied on self-reported behaviours. Measured behaviours included:

Beh1:

- Recycling paper, plastic, glass bottles, cardboard, aluminium cans, or other products
- Repairing items as much as possible
- Reusing different products
- Reduction in waste generation
- Selection of products based on carbon footprint
- Buying energy-efficient products
- Purchase of environment-friendly products
- Buying recycled products

Beh2:

- Purchase or building energy-efficient buildings
- Purchase or building sustainable buildings
- Purchase or building buildings with lower carbon footprint
- Purchase of environmentally-friendly building materials
- Purchase of building materials locally produced
- Purchase of building materials with lower carbon footprint
- Purchase of reclaimed building materials

- Purchase of recycled building materials

Attitude (NEP): The New Environmental/Ecological Paradigm (NEP) scale is one of the richest measurement tools for predicting behaviour from attitudes (Roberts & Bacon, 1997). A short version was developed with a 6-item scale in 2008, which is used in this study. The NEP scale captures a person's general environmental beliefs.

Subjective norm (SN): The subjective norm can be defined as an individual's perceptions of general social pressure to perform a behaviour (Armitage & Conner, 2001). Recycling is a behaviour influenced not only by personal motivation but also by community and social motives (Klöckner, 2013). Kumar and Ghodeswar (2015) also identified social appeal as an influential factor in green product purchase.

SN: Social influence. Items were:

- People are more concerned about reuse or recycling of materials these days.
- Everyone has some people around who have influenced their environment-friendly behaviours.

Perceived behavioural control (PBC): Klöckner used Ajzen's definition of perceived behavioural control in his research as "the person's belief as to how easy or difficult performance of the behaviour is likely to be". This definition can be extended to internal factors like abilities and knowledge, and external factors like opportunity and the cooperation of other stakeholders that lead to the behaviour (Klöckner, 2013).

PBC1: Influential factors on purchasing environmentally friendly products and specifically RRBMs such as price, access, transparency of information, and manufacturers' performance. Items include:

- Price plays an important role in buying RRBMs.
- RRBMs are usually available in your nearby suppliers' stores.
- Required information for deciding on RRBMs are easily accessible.
- You can easily find specifications of RRBMs.
- People normally find any RRBMs that they want from suppliers near their living areas.
- People's purchase behaviour of RRBMs are based on price to a great extent.
- Producers and suppliers of RRBMs know what their consumers want.
- Producers and suppliers of RRBMs communicate enough with people.

PBC2: Knowledge of relevant certificates and regulations. Items include:

- There are enough regulations related to RRBMs.
- You have knowledge about regulations related to the use of RRBMs in the building construction process.
- There are enough building certificates related to RRBMs.
- There are enough building material certificates related to RRBMs.

Intention (Int): Lack of motivation is one of the barriers to reducing waste (Chung & Poon, 1999). In TPB, the intention is to find a determinant that can be called a plan for the behaviour that in conjunction with other factors enables the person to perform environmental behaviours (Klößner, 2013).

Int1: Purchasing or building environmentally friendly, sustainable buildings with a reduced carbon footprint. Items were:

- Building or Purchase of sustainable buildings
- Building or Purchase of buildings with lower carbon footprint
- Purchase of buildings made with materials responsibly produced

Int2: Purchasing locally produced, RRBMs. Items were:

- Purchase of environment-friendly building materials
- Purchase of reclaimed building materials
- Purchase of recycled building materials

6.3.1 Descriptive statistics

A review of the literature indicated that a variety of statistical analyses are appropriate for testing the TPB. Here regression analysis has been used in order to predict behaviour through intention and other relevant factors. Correlation analysis can show the strength of relationships between variables for each construct.

Reliability analysis was done by measuring Cronbach's coefficient alpha for the NEP scale (see section 6.2.). Cronbach's alpha was 0.667, being higher than in similar studies and within the acceptable range for measuring environmental attitudes (Lovell, 2010; Versus Research Ltd, 2013).

Prior to examining the TPB, the correlation between the components of each construct were tested for each question. Pearson product–moment correlation coefficients showed a moderate to strong positive correlation, ranging from 0.39 to 0.82. Since the content to be questioned for each item was different, there was no need for factor analysis. In other words, the purpose of each question was different, so they were categorised based on that. Content validity of the study has been proved by some results that were expected. This means the results accord with those found in the literature, as discussed later in this section. Assumptions prior to the stepwise linear regression analysis will also be examined.

The first sample consisted of 159 architects. Based on the NZIA statistics, 20% of all Registered Architects and NZIA Fellows are female (NZIA, 2018). In this study, 34% of architects are women, so the sample is over-represented in terms of having more women than the main population group. Although, in this thesis the focus is on the group of architects as a whole, more information on demographic differences in the sample is available elsewhere (Balador, Gjerde, & Isaacs, 2020b).

6.3.2 Correlations

The preliminary investigation of the TPB was the correlation analysis for the constructs introduced earlier in this chapter. Assumptions for Pearson and Spearman tests were not met so a Kendall's tau_b correlation was run to determine the relationship between the different constructs because it was a non-parametric and ordinal data set. The results are presented in Table 18. Two asterisks have been put next to the degree of correlation to show the significance at the alpha levels of 0.01. When the degree of correlation is more than 0.25 this indicates a relationship between variables.

Table 18. Correlations between the TPB components

	PBC1	PBC2	Int1	Int2	Beh1	Beh2	SN
NEP	.033	-.058	.292**	.228**	.246**	.240**	0.83
	PBC1		.133	.155	.024	-.031	.148
		PBC2	-.042	-.091	.088	.117	.022
			Int1		.334**	.291**	.101
				Int2	.320**	.231**	.108
					Beh1		.084
						Beh2	.121

** . Correlation is significant at the 0.01 level (2-tailed).

There were positive correlations between NEP with Int1, Int2, Beh1 and Beh2, which were statistically significant. But only the relationship between NEP and Int1 was more than 0.25. Also, Int1 and Int2 had a positive relationship with Beh1 and Beh2, which were statistically significant. But the relationship between Int2 and Beh2 was not more than 0.25.

In the light of these results, the NEP scale measurement has shown a positive correlation with reuse and recycling behaviour in both personal life and practice, but it is low degree of correlation. This is consistent with similar studies suggesting there is a relationship between environmental attitudes and practices (Begum et al., 2009; Hines et al., 1987; Li et al., 2015; Ogunbode, 2013; Vining & Ebreo, 1992). As these studies suggest, this holds especially true if the NEP scale is used for measuring attitudes. Also, the highest degree of correlation was between environmental attitude and Int1. The first components of intention about sustainable buildings and materials are also positively correlated with behaviour that supports the TPB, and this is not surprising since architects know building materials enough to care about the right selection of them. From another perspective, architects appear to think environmentally, intend to do what they believe, and have stated that they have done some of the activities, and there are significant statistical correlations to support this, noting that their behaviour results are self-reported.

The fact there is no correlation between these factors and perceived behavioural control and subjective norm can be due to architects believing the social motives, abilities and opportunities are not satisfactory for encouraging recycling and reuse of building materials. This might be because architects suggest the use of these materials, but it is the client who decides to accept or refuse them. There are other barriers like accessibility and lack of information that affect the behaviour of architects, which may be why PBC is not related to the other constructs. Overall, it seems that

environmental attitudes, intention and behaviour make a good triangle of correlation and this correlation is stronger than for other components of the TPB.

6.3.3 Regression Analysis

Assumptions of normality, linearity, homoscedasticity and independence have been checked in the data, and were not violated (see Appendix 6).

6.3.3.1 *Prediction of intention by using the results of NEP and perceived behavioural control components:*

A stepwise linear regression analysis was carried out to predict intention from the TPB components. According to the TPB, intention as the first predictor of behaviour was examined as a dependent variable and all other components as independent variables.

NEP statistically significantly predicted Int1, with the equation $F(1, 140) = 12.301$, $p = .001$, $R^2 = .081$ (Table 19). Both NEP and PBC1 statistically significantly predicted Int2. The equation was $F(2, 139) = 5.899$, $p = .003$, $R^2 = .078$ (Table 20). When the p-value is less than 0.05, the predictor can be a meaningful addition to the model. It means that changes in the values of the predictors are related to changes in the response values. All other variables including PBC components did not add to the prediction significantly. The present information from the predictors of intention shows that NEP is the strongest predictor of intention both for Int1 which is about the general intention of buying and building sustainable buildings, and Int2 which is about the use of RRBMs. When examining Int2, PBC1 is also a predictor, as PBC1 concerns influential factors on purchasing environmentally friendly products, including price, access, transparency of information, and manufacturers' performance. This is consistent with the literature (Freeman, 1990; Li et al., 2015; Ottman, 1998). These components of PBC (PBC1) are stronger predictors of intention compared to other components of PBC such as regulations and responsibilities.

It seems that knowing the level of architects' environmental attitudes means their intention can be predicted, and when it comes to the intention of using RRBMs, knowing about price, access, transparency of information, and manufacturers' performance would also be important.

Table 19. Stepwise linear regression analysis with Int1 as the dependent variable, and NEP and PBC components as independent variables

Model	B	Std. Error	Beta	t	Sig.
(Constant)	3.206	.386		8.298	.000
NEP	.313	.089	.284	3.507	.001
a. Dependent Variable: Int1					
b. Adjusted R square: .074					
c. Std. Error of the estimate: .598					

Table 20. Stepwise linear regression analysis with Int2 as the dependent variable, and NEP and PBC components as independent variables

Model	B	Std. Error	Beta	t	Sig.
(Constant)	2.396	.559		4.290	.000
NEP	.259	.095	.222	2.726	.007
PBC1	.267	.122	.178	2.183	.031
a. Dependent Variable: Int2					
b. Adjusted R square: .065					
c. Std. Error of the estimate: .638					

6.3.3.2 Prediction of behaviour using the results of NEP and perceived behavioural control and intention components:

A stepwise linear regression analysis was carried out to predict behaviour from the TPB components. After considering Intention as the dependent variable, Behaviour was examined as the dependent variable and all other components of NEP, PBC, SN and Intention as independent variables. Int2, NEP and PBC2 statistically significantly predicted Beh1, $F(3, 134) = 17.308$, $p = .000$, $R^2 = .279$ (Table 21). Beh2 was statistically significantly predicted from NEP and Int2, $F(2, 116) = 10.873$, $p = .000$, $R^2 = .158$ (Table 22).

Table 21. Stepwise linear regression analysis with Beh1 as dependent variable, and NEP, PBC and Int components as independent variables

Model	B	Std. Error	Beta	t	Sig.
(Constant)	-3.486	1.385		-2.517	.013
Int2	1.111	.211	.396	5.262	.000
NEP	.840	.248	.255	3.388	.001
PBC2	.433	.198	.161	2.193	.030
a. Dependent Variable: Beh1					
b. Adjusted R square: .263					
c. Std. Error of the estimate: 1.593					

Table 22. Stepwise linear regression analysis with Beh2 as dependent variable, and NEP, PBC and Int components as independent variables

Model	B	Std. Error	Beta	t	Sig.
(Constant)	-3.810	1.880		-2.027	.045
NEP	1.201	.396	.270	3.037	.003
Int2	.812	.321	.225	2.526	.013
d.	Dependent Variable: Beh2				
e.	Adjusted R square: .143				
f.	Std. Error of the estimate: 2.263				

It is clear from the results that Int2, NEP and PBC are the strongest predictors of behaviour. For Beh1, strong predictors are Int2, NEP and PBC2. For Beh2, strong predictors are only NEP and Int2. From these results, it appears that Int2, that is the intention to use RRBMs, can be more related to general recycling behaviour and then to this behaviour in construction practices. This is consistent with the literature in that environmental attitude (NEP) can be a good predictor of both recycling behaviours in general and in construction practices, but more in construction practices (Begum et al., 2009; Li et al., 2015; Ogunbode, 2013), although it is not always a good predictor for other environmental behaviours. Also, another reason as Thøgersen (1994) said is that in affluent countries like New Zealand, environmental actions can be more predicted from attitudes. Interestingly, PBC2 which is associated with related regulations and certificates for RRBMs, proved to be a stronger predictor when it came to the prediction of Beh2, which is about recycling in construction practices, and shows the validity of the core intent of the questions asked as another proof of the content validity. This mirrors the results of Klockner's study (Klößner, 2013). So, measuring the environmental attitudes and intention of architects can help in predicting reuse and recycling in the building construction process; that said, the knowledge of architects about regulations and certificates can also have an effect on their general recycling behaviour. Since architects have one of the most critical roles in encouraging clients to use RRBMs, knowing their responsibilities can be a trigger for greater use of these in construction projects. As mentioned by Ajzen (1991), specifying questions and having a specific target population can better show the correspondence of the components of the TPB. Regression analysis results also revealed an understanding of the whole relationships in the TPB (Figure 21). The bolder the arrows the more significant the relationship in Figure 21. The findings of this statistical analysis are consistent with the

study of Li et al. (2015), who found attitudes and PBC were the two most important predictors of behaviour among designers and architects.

As can be seen in Figure 21, environmental attitude, perceived behavioural control and intention play a role in the relationship model, but the main contributors are environmental attitude and intention. So, a higher degree of environmental attitude will lead to more use of RRBMs and more reuse and recycling activities. Besides, intention as the next predictor is influenced by environmental attitude and perceived behavioural control. Therefore, facilitating the purchase of RRBMs, and increasing knowledge of related regulations and certification will lead to more use of RRBMs and more reuse and recycling activities through intention or directly. These factors represent the control over the behaviour, and intention is how hard someone is willing to perform the behaviour and this is assumed to capture these motivational factors. So as long as these opportunities and resources are provided, if someone intends to use RRBMs or undertakes reuse and recycling, he or she should succeed in performing that behaviour.

Figure 21. Predictors of Behaviour according to the results of the regression analysis (Balador, Gjerde, Vale, & Isaacs, unpublished)

6.3.4 Summary

Prior to establishing a behaviour, understanding the process within which the behaviour is taking shape is essential. This section addressed the gap in knowledge regarding the relationship of the NEP scale to recycling and buying recycled building materials as a pro-environmental behaviour. This study also added to the literature by examining the TPB using a particular population (architects).

The findings were that some components of the TPB are more relevant for the prediction of environmental behaviour. Some have a statistically significant relationship and add to the prediction of the behaviour of architects in terms of general reuse and recycling, and the specific use of RRBMs. The most important predictor components were the intention of using RRBMs, environmental attitudes, and perceived behavioural control. This means that architects with stronger environmental attitudes (NEP) have stronger intentions (Int) to do more recycling or buy more

recycled materials (Beh). However, their intentions (Int) for doing these behaviours are also influenced by some of the factors affecting green purchase behaviour (PBC1). Also, when architects know more about regulations and certificates related to the use of these materials (PBC2), they do more of these pro-environmental practices. An additional finding was that subjective norm can be removed from the model for this group of people. The main findings of this study were consistent with previous studies that have examined the TPB. However, small modifications were made to the TPB model according to the results (Figure 21).

One of the obstacles to improving waste management practices is the attitude of people towards recycling in the building construction process. As construction activities are labour intensive, these human factors and the attitudes that inform them are critically important in order to reduce waste levels (Begum et al., 2009). Policymakers can enhance perceived behavioural control by increasing designers' awareness of waste management through changes in legislation and through education programs (Li et al., 2015). Studies have focussed on the role of government and environmental legislation in protecting the environment (Kalantari et al., 2007), and others have shown that a key barrier is the lack of training and expertise in the construction industry when it comes to environmental practices (L. Shen & Tam, 2002). Since PBC2 was one of the important factors, further studies need to focus on policies and regulations regarding the use of these building materials, and on other stakeholders involved in the construction industry. Based on this study alone, recommendations can be made in terms of policy and certification to facilitate both the purchase of RRBMs and more reuse and recycling activities in the building construction process (see section 9.9).

6.4 Comparison of the behaviour of stakeholder groups

Assumptions of normality, linearity, homoscedasticity and independence have been checked, and were not violated. A stepwise linear regression analysis was carried out to predict intention from the TPB components. Intention as the first predictor of behaviour has been examined as a dependent variable and all other components as independent variables. Also, a stepwise linear regression analysis was carried out to predict behaviour from the TPB components. After considering Intention as the dependent variable, behaviour was examined as the dependent variable and all the other components of NEP (environmental attitude), PBC, SN and Intention as independent variables.

This analysis was first carried out for the whole sample and then for each group of stakeholders separately to look for similarities and differences between groups. The analysis procedure was explained for the architects' group in section 1.4. In this section only final behavioural models have been compared.

6.4.1 The whole sample

The whole sample of all six groups of stakeholders was tested to find the predictors of behaviour. NEP and PBC1 statistically significantly predicted Int1, with the equation of $F(2, 592) = 50.146$, $p = .000$, $R^2 = .145$. Also, both NEP and PBC1 statistically significantly predicted Int2. The equation was $F(2, 592) = 32.004$, $p = .000$, $R^2 = .098$. the results showed that NEP was the strongest predictor of both Intentions, followed by PBC1. NEP is the measure of environmental attitudes and PBC1 concerns influential factors on purchasing environmentally friendly products, including price, access, transparency of information, and manufacturers' performance. Other variables were not helpful in the prediction of Intentions (Figure 22).

In terms of the prediction of behaviour, Beh1 could be predicted by Int1, NEP and Int2, and Beh2 only by Int2. Int1, NEP and Int2 statistically significantly predicted Beh1, with the equation of $F(3, 574) = 43.025$, $p = .000$, $R^2 = .184$. Also, Int2 statistically significantly predicted Beh2, with the equation of $F(1, 416) = 19.513$, $p = .000$, $R^2 = .045$. It is clear from the results that for Beh1, strong predictors are Int1, NEP and Int2 in the order of importance, and for Beh2 only Int2 is a strong predictor. From these results, it appears that Int2, the intention to use RRBMs, is a strong predictor for both general recycling behaviour and this behaviour in construction practices. Besides, for both Intentions, NEP and PBC1 are strong predictors in that order. So, measuring environmental attitudes, influential factors on purchasing environmentally friendly products, and intention can help in predicting reuse and recycling in building construction (Figure 22).

Figure 22. Behavioural model of the whole sample based on the TPB.

6.4.2 Manufacturers/ suppliers

The group of manufacturers/suppliers included all of the surveyed businesses who produce and sell RRBMs. Statistical results showed that most of the components of the TPB were not good predictors of behaviour. NEP statistically significantly predicted Int1, with the equation of $F(1, 89) = 11.341$, $p = .001$, $R^2 = .113$. Int2 was also predicted by PBC1 and NEP, with the equation of $F(2, 88) = 4.664$, $p = .012$, $R^2 = .096$. It seems that NEP was stronger in the prediction of Int1 than Int2 (Figure 23).

Prediction of behaviour showed that only Beh1 was predictable and the sole predictor was Int1. The equation is $F(1, 88) = 6.224$, $p = .014$, $R^2 = .066$. Other TPB components could not predict Beh2 and Beh1, which is about predicting general recycling behaviour by knowing the intention of buying and building sustainable buildings. Also, NEP did not directly predict behaviour. Compared to the other groups, this group exhibited limited relationships between the components of the TPB. It means it is harder to predict their behaviour and their behavioural model is somewhat different (Figure 23). The lack of relationship might be explained by the fact the suppliers group included both recyclers and non-recyclers, forming two sub-groups.

Figure 23. Behavioural model of manufacturers and suppliers group based on the TPB.

6.4.3 Builders

Building practitioners and contractors are included in this group. Results indicated that NEP and SN statistically significantly predicted Int1, with the equation of $F(2, 146) = 12.140, p = .000, R^2 = .143$. Int2 was also predicted by NEP with the equation of $F(1, 147) = 8.168, p = .005, R^2 = .053$. So NEP as usual was a strong predictor of Intentions, but interestingly SN was also a good predictor of Int1, coming after NEP. Subjective norm which is the individual perception of social pressure to perform a behaviour was a predictor of intention to buy and build sustainable buildings but could not contribute to the prediction of intention and behaviour (Figure 24).

Statistical results of the prediction of behaviour indicated that Beh1 could be predicted by Int2 and NEP in the order of importance. The equation was $F(2, 141) = 12.191, p = .000, R^2 = .147$. Beh2 was predicted by Int2 with the equation of $F(1, 120) = 4.919, p = .028, R^2 = .039$. It seems Int2, which was about the intention to use RRBMs, was a strong predictor for both general recycling behaviour and recycling in construction. Surprisingly, Int1 was not a good predictor of behaviour (Figure 24).

Figure 24. Behavioural model of builders group based on the TPB.

6.4.4 Architects/ designers

The architects group included architects, graduate architects, and designers. The complete analysis has been explained in section 1.4. The diagram has been given here for comparison with the other stakeholder groups (Figure 25).

Figure 25. Behavioural model of architects group based on the TPB.

6.4.5 NGOs/ environmentalists

People in related NGOs and environmentalists in the areas related to the reuse and recycling of building materials were included in this group. Most of the components of the TPB do not predict behaviour for this group. NEP was a predictor of Int1 and Beh1. The equation for the prediction of Int1 was $F(1, 43) = 11.934$, $p = .001$, $R^2 = .217$. Int2 cannot be predicted by these components. Beh1 was predicted by NEP and PBC1 in this order of importance, with the equation of $F(2, 41) = 13.697$,

$p = .000$, $R^2 = .401$. So reuse and recycling could be predicted by knowing about environmental attitudes and influential factors on purchasing environmentally friendly products, including price, access, transparency of information, and manufacturers' performance (Figure 26).

Figure 26. Behavioural model of environmentalists group based on the TPB.

6.4.6 Regulators

This group included people who apply regulations like city councils, those who do research that ends up in making regulations, and regulators related to the building construction. Most of the components of the TPB did not contribute in the behavioural model of regulators. Int2 was predicted statistically significantly by PBC1 and NEP, with the equation of $F(2, 41) = 4.975$, $p = .012$, $R^2 = .195$. Int1 was not predicted by any component and did not predict behaviour. Beh1 was predicted statistically significantly by NEP, with the equation of $F(1, 42) = 7.033$, $p = .011$, $R^2 = .143$. None of the TPB components predicted Beh2 for regulators. So, reuse and recycling can be predicted by just knowing environmental attitudes of regulators (Figure 27).

Figure 27. Behavioural model of regulators group based on the TPB.

6.4.7 Consumers

Any respondent who answered the question on occupation by choosing “none of the above” was placed in the consumer group. Since these people were interested in the study of reuse and recycling of building materials and their occupation was not related to this they could be counted as potential consumers of these materials. Examining the TPB for the consumer group showed that NEP and SN statistically significantly predicted Int1 and Int2 with the equations of $F(2, 121) = 27.084$, $p = .000$, $R^2 = .309$, $F(2, 41) = 19.486$, $p = .000$, $R^2 = .244$, respectively. Beh1 was predicted statistically significantly by Int1 and NEP. The equation was $F(2, 115) = 10.260$, $p = .000$, $R^2 = .151$. So, reuse and recycling can be predicted by the intention of buying and building sustainable buildings and directly by measuring environmental attitudes (Figure 28).

Figure 28. Behavioural model of consumer group based on the TPB.

6.4.8 Summary

Comparing the stakeholder groups shows that NEP is always a strong predictor for Intentions and Behaviours in this study and sometimes directly predicts the relevant behaviours. The next strong predictor is PBC1, which is about factors that influence the purchase of environmentally friendly products, including price, access, transparency of information, and manufacturers' performance. In most cases, PBC1 statistically significantly predicted Int2. PBC2 which is about the knowledge of relevant certificates and regulations only predicted Beh1 for the architect group. Also, SN which is about the social influence, only predicted Int1 for consumers and builders. Int2 is a better predictor of behaviour than Int1. Beh1 which is general reuse and recycling behaviour is more predictable based on the TPB components, and Beh2 is predicted by NEP and Int2 for architects and builders.

In the light of these results, for manufacturers, Beh1 is predicted through Int1 and NEP. For builders, both Beh1 and Beh2 were predicted by Int2 and NEP. For architects, except for SN and Int1, all components contributed to the prediction of behaviour. For environmentalists, Beh1 was predicted by NEP and PBC1 directly and intentions did not contribute. For regulators, Beh1 was only predicted by NEP and intentions had no role in this prediction. For consumers, Beh1 was predicted through Int1, NEP and SN, and this was the only group where SN contributed in the prediction of behaviour.

Looking only at the whole sample gives a different picture. The main contributors to the prediction of the Behaviours for the whole sample were NEP, PBC1, Int1 and Int2. Both Behaviours were predictable through Intentions and Beh1 was also directly predicted by NEP. NEP and PBC1 both predicted Int1 and Int2. However, Beh1 was predicted through more components, while Beh2 was only predicted by Int2. The final point is that examination of the components of the TPB offers some insight into the prediction of general reuse and recycling behaviour in building construction, and specifically the use of RRBMs. NEP (environmental attitudes), PBC1 (influential factors on purchasing environmentally friendly products, including price, access, transparency of information, and manufacturers' performance), Int1 (intention of buying and building sustainable buildings) and Int2 (intention of the use of RRBMs) were the main factors in predicting the behaviour of the selected stakeholders in the construction industry.

6.5 Effect of sociodemographic data on behaviour

Comparing the results of Beh1 and Beh2 by gender showed that Beh1 was higher for women ($M=6.4$, $SD=1.7$) than men ($M=5.5$, $SD=2.0$), $t(577)=-461.70$, $p = 0.000$. This is consistent with previous studies (Hawcroft & Milfont, 2010; Hur et al., 2015) in that women do more environmentally friendly activities.

Figure 29. The influence of education level on the general behaviour of reuse and recycling

The results showed no differentiation by age, but Beh1 was significantly different for level of education. A Post Hoc test showed that respondents with “Trade/technical/vocational training” have a lower score for Beh1 than respondents with “bachelor degree” or “post graduate degree”, and this also conforms with the results of previous studies (Steel, Smith, Opsommer, Curiel, & Warner-Steel, 2005; Thomson & Versus Research Ltd, 2008) (Figure 29). Income level, number in the household, and house ownership showed no difference in the Behaviours. Differences were only statistically significant when P level was less than 0.05.

6.5.1 Effect of occupation on behaviour

The One-Way ANOVA test revealed occupation had a statistically significant influence on the Behaviour of respondents, both for Beh1 and Beh2. Post Hoc comparisons indicated that for Beh1, the average for manufacturers was lower than that of all other groups except builders. The average for builders was lower than those of architects, environmentalists and regulators. The average for architects was lower than for environmentalists but higher than for manufacturers and builders, with environmentalists having the highest average. For Beh2, statistical results indicated that the average for manufacturers was lower than for architects and regulators. The average for architects

was also higher than for manufacturers and consumers. Only statistically significant differences have been mentioned in this analysis, all of differences are shown in Figure 30.

Figure 30. The influence of occupation on the general behaviour of reuse and recycling and in construction.

6.5.2 Conclusion

Overall, for socio-demographic data and occupation only gender and education had some statistically significant effect. Women and people with bachelor and post graduate qualifications were more likely to undertake reuse and recycling. For occupation, manufacturers, builders and consumers were less likely and environmentalists, regulators and architects more likely to undertake reuse and recycling and in their personal lives and in construction. This is useful, as it might be possible to make better connections between stakeholders so that these behaviours increase. Environmentalists and regulators were most likely to undertake general reuse and recycling, which is linked to the nature of their professions and responsibilities. However, architects and builders are two stakeholder groups could inform consumers and manufacturers and negotiate with environmentalists and regulators so that all groups come closer together.

6.6 Influential factors on green purchasing behaviour related to RRBMs

6.6.1 Descriptive statistics

The first two statements in the questionnaire measured the general knowledge of respondents. One asked people how strongly the construction industry pollutes and the second about the benefits of

using RRBMs. The results showed that respondents were unclear whether the construction industry is one of the most polluting industries in New Zealand. Despite the fact the respondents represent the key stakeholder groups in the building construction industry, they are not aware of its polluting nature. However, most respondents (66%) agreed that the benefits of using RRBMs would outweigh the drawbacks.

One of the key reasons why people did not use RRBMs was their poor availability, as 50% of respondents stated that they could not find these products in the stores of nearby suppliers and 30% stated that they had inadequate information on their availability. This issue was also affected by other factors like advertising, although only 20% of people disagreed with the statement that they would buy these products because they are influenced by advertisements. This shows that advertisements, as for other products, have an impact on people's purchasing behaviour. This aligns with the literature finding that green purchasers are more conscious of the transparency of information relating to products (Grimmer & Bingham, 2013; Tilikidou, 2013). Therefore, it is not only a matter of advertising, but also access to product information. This study also found that only 12% of respondents said they would need information that was easily available when purchasing a RRBm. When it comes to the use of building materials, knowing the specifications of a material is a key fact influencing the purchase behaviour because of the need to meet building codes and standards.

Respondents then answered questions regarding their perceptions of the producers and suppliers of RRBMs. Most (76%-79%) believed that the public, environmental image of the manufacturer or supplier was important when buying building materials. In addition, 36% believed producers did not communicate enough with people to understand their needs, although 43% of respondents did not have an opinion on this issue. However, 61% of respondents agreed there was a gap between the claims made by producers and the performance of their products and only 4% thought there was no gap. This is also consistent with the literature where a usual reason why people do not trust environmentally-friendly products is because of this gap in information (Britzelmaier & Burger, 2012; Grimmer & Bingham, 2013).

6.6.2 Effect of socio-demographic data

Multiple regressions were run to predict influential factors related to gender, age, education, and income. Results showed that "knowledge of impacts of construction industry" and "increasing

concern among people” cannot be predicted by demographic variables, but age and gender statistically significantly predicted “self-satisfaction”, $F(2, 624) = 7.774, p = .000, R^2 = .024$. Women believed that “self-satisfaction” was more important in a green purchase than men, and for age “self-satisfaction” was more important for older people than younger people. Also, age was a predictor of “price”, $F(1, 625) = 25.932, p = .000, R^2 = .040$, and “availability”, $F(1, 625) = 9.277, p = .002, R^2 = .015$. This means that older people thought that price was more important in their purchase behaviour on the assumption that recycled and reused building materials and components were available. Interestingly, income predicted (statistically significant) a negative view of “advertisement”, $F(1, 625) = 19.169, p = .000, R^2 = .030$, in that people with higher incomes thought that advertisement did not have that much effect on their purchase behaviour. Similarly, age and income predicted a lack of “accessibility of information”, $F(2, 624) = 8.590, p = .000, R^2 = .027$. That is older people and people with higher incomes thought that information on which to base the decision to choose these materials and products was not easily accessible. Income and gender were statistically significant predictors of “knowledge of benefits”, $F(2, 624) = 7.542, p = .001, R^2 = .024$. Women thought that use of these materials had more benefit, but “knowledge of benefit” had an outcome with income, which means people with higher incomes did not think the same way. Age and gender were statistically significant predictors of the “public” and “environmental” image of companies, $F(1, 605) = 15.143, p = .000, R^2 = .024, F(1, 605) = 7.918, p = .005, R^2 = .013$, respectively, with “public image” being more important for younger people and “environmental image” being more important for women. Also, gender was a statistically significant predictor of “gap between claim and performance”, $F(1, 605) = 6.825, p = .009, R^2 = .011$, with men being more suspicious about the gap between the claims and performance of producers.

It is clear from the results of the regression analysis that age, gender, and income, especially age in most cases, were statistically significant for the prediction of influential factors, at $p < .005$. This finding is consistent with studies in the literature that found the predictability of these influential factors on green purchase behaviour based on the socio-demographic data, and specifically the same three variables of age, gender, and income (Dunlap et al., 2000; Hawcroft & Milfont, 2010; Hur et al., 2015).

6.6.3 Effect of the role of the stakeholder

Influential factors were also compared for the different groups of stakeholders through one-way ANOVA tests. This showed stakeholders have statistically different opinions about the fact the construction industry is one of the most polluting industries, ($F(5,621) = 4.242, p = .001$). The analysis also revealed that architects knew more about this than manufacturers and consumers. There was a statistically significant difference between groups as determined by one-way ANOVA tests for “increasing concern among people”, that refers to the two statements in questionnaire that people are becoming more concerned about reuse and recycling, and engaging in environmentally friendly behaviours ($F(5,621) = 5.592, p = .000$). A Tukey post hoc test revealed that manufacturers agree more than builders, environmentalists, and regulators, and consumers agree more than environmentalists that there is a growing environmental concern for reuse and recycling. Also, ANOVA tests showed that perceptions about the “availability” of RRBMs differ between the stakeholders, ($F(5,621) = 4.168, p = .001$) and based on a Tukey post hoc test, consumers had a more positive attitude towards availability than builders, architects, and environmentalists. Accessible “information” is another item where respondents differed. This was statistically different ($F(5,621) = 7.395, p = .000$) and a Tukey post hoc test showed that manufacturers thought more positively than regulators that information for purchasing RRBMs was easily available, and consumers also thought more positively about this issue than builders, architects, environmentalists, and regulators. The perceptions of respondents about the “communication” of producers with consumers were also statistically different at ($F(5,601) = 2.935, p = .013$) and based on a Tukey post hoc test, consumers and manufacturers agreed more than architects that producers of these building materials communicate sufficiently with their consumers. This may have been in part due to the fact that specialists were more aware of this lack of communication than lay people.

There was no significant difference for “self-satisfaction”, “price”, “advertisement”, “public image”, “environmental image”, “gap of claim and performance”, and “knowledge of benefits” between the different stakeholder groups.

This study suggested that environmentalists are not optimistic about environmental issues, which can in part be a consequence of the nature of their professional interests compared to others. Similarly, regulators are more negative than others in their views of environmental issues. As seen in Figure 31, when the question is about environmental problems experts (regulators, environmentalists and architects) tend to agree, but when it is about influential factors they

disagree. Comparison of opinions regarding these factors (increasing concern, availability, accessibility of information, communication) indicates that the general trend of respondents is the same across the different stakeholder groups.

Figure 31. Different perceptions of stakeholders adapted from (Balador, Gjerde, & Isaacs, 2020a)

6.6.4 Summary

Studying the perceptions of stakeholders in the construction industry and investigating their differences when it comes to perceptions of opportunities is a first step towards the sustainable transformation of the built environment. In the light of the results, although RRBMs are an environment-friendly alternative to conventional materials, price, availability, and other normal influential marketing factors still play their role in the purchasing behaviour of consumers. However, price and self-satisfaction are the most influential factors in this study based on the percentage of people who agreed or strongly agreed to the influence of them on their purchasing behaviour, which is shown in the descriptive statistics results. Another study found green purchasers are more careful, price conscious, not loyal to brands, and favour new products and communicated product information (Shrum et al., 1995) more than normal consumers. This finding should be considered by producers, manufacturers, and suppliers since people pay attention to the image producers show to society and they can see any gap between claims and performance. For building materials, at the end of the day it is the architect who decides on material choice and architects are more aware and

knowledgeable about the required specifications of materials than people who do not have related occupations. Examination of predictors of the influential factors and the sociodemographic data of stakeholders offers insight into the fact that age, gender, and income are three strong predictors, which could be helpful for producers when planning future strategies.

6.7 Three pillars of sustainability

The three pillars of sustainability are normally given as the social, economic and environmental. Earlier studies (Moldan, Janoušková, & Hák, 2012) showed that economic growth is basically dependent on the availability of natural resources, and although in recent decades it has been both the goal of societies and politicians, the fact resources are limited in a finite world shows there should be a balance between economic growth and sustainability. This kind of imbalance can be one reason behind an economic crisis (Moldan et al., 2012). Reduction in extraction, production, transportation, and disposal costs is one benefit of reclaimed and recycled products (Lacy & Rutqvist, 2015). The benefits of a circular economy have been discussed in the literature (see section 2.1.1).

Gilbert et al. (2013) state there are common goals in a society, and the cohesion towards achieving them needs social sustainability, and this includes sustainability related to health, education, and culture (Gilbert, Stevenson, Girardet, & Stren, 1997). The wealth of societies primarily lies in their human and social capital. Indicators of social sustainability could be human well-being, maintenance of culture and history, and employment opportunities (Lacy & Rutqvist, 2015).

Goodland (1995) developed the concept of environmental sustainability, and said that it is the improvement of human welfare while allowing for the limits in the sources of raw materials and human needs while controlling waste production and pollution harmful to human beings (Goodland, 1995). Environmental sustainability could thus cover issues like CO₂ emissions, scarcity of natural resources, pollution, and toxins (Lacy & Rutqvist, 2015).

6.7.1 Descriptive statistics

A Friedman test compared the mean ranks of environmental, economic, and social aspects as the three pillars of sustainability based on the evaluation of the survey respondents. Descriptive statistics show that the ranks of these three aspects are significantly different, with a chi-square

value of 451.912, $p = 0.000$. The rank of the environmental aspect is higher than that of the economic and social, being 1.33, 2.12 and 2.55 respectively (Figure 32).

Figure 32. Friedman's test results for the evaluation of three pillars of sustainability based on the stakeholders' perception

6.7.2 Effect of socio-demographics

A Kruskal Wallis test was run to check for differences in the evaluation of the three pillars of sustainability based on the socio-demographics (Table 23). Results show there was a significant difference between men and women for the evaluation of all three pillars ($H(1)=4.302$, $p=0.038$), and also for different educational levels ($H(4)=9.942$, $p=0.041$). Mean ranks presented in the following table show that females gave more importance to environmental and social aspects compared to men and vice versa for the economic aspect.

Table 23. Mean rank of three pillars of sustainability for different education level and men/ women

	Education	N	Mean Rank	Gender	N	Mean Rank
environmental	Secondary school (college)	40	268.70	Male	388	302.69
	Trade/technical/vocational training	177	313.33	Female	200	278.62
	Bachelor's degree	173	274.46			
	Post graduate degree	188	298.67			
	None of the above	10	332.60			
economic	Secondary school (college)	40	267.40	Male	388	276.97
	Trade/technical/vocational training	177	253.34	Female	200	328.51
	Bachelor's degree	173	328.24			
	Post graduate degree	188	308.18			
	None of the above	10	290.50			
social	Secondary school (college)	40	351.60	Male	388	307.87
	Trade/technical/vocational training	177	327.36	Female	200	268.57
	Bachelor's degree	173	278.18			
	Post graduate degree	188	267.51			
	None of the above	10	274.40			
Total		588			588	

In terms of educational levels, mean ranks show that respondents with a college qualification gave marginally more importance to the environmental aspect compared to others, respondents with vocational training gave more importance to the economic aspect, and respondents with a post graduate degree gave slightly more importance to the social aspect. In terms of other sociodemographic data there was no significant difference between respondents.

6.7.3 Effect of occupation

Comparing the mean ranks across the stakeholder groups revealed the results of environmentalists and builders are different for all three pillars. This means the environmentalists gave the highest rank to environmental and social aspects compared to other groups, and the opposite for the builders group. In terms of economic issues, the builders group gave this the highest rank compared to other groups and the environmentalists the lowest rank. However, in terms of environmental aspects, the difference between groups was not statistically significant, ($H(5)=7.456$, $p=0.189$) with a mean rank of 313.50 for builders who gave the lowest importance to the environmental aspect and 256.57 for environmentalists who gave the highest. In addition, in terms of economic and social issues there was more difference, ($H(5)=35.688$, $p=0.000$) and ($H(5)=30.583$, $p=0.000$). The mean rank for the economic aspect for builders was 245.49 who gave the highest importance to the economic aspect and 386.50 for environmentalists who gave the lowest. The mean rank in the social aspect for builders was 334.25 who gave the lowest importance to the social aspect and 231.63 for environmentalists who gave the highest. The graph (Figure 33) shows that environmental and social trends were similar but economic trends differed.

Figure 33. Mean rank of three pillars among different stakeholders

6.7.4 Other benefits of using RRBMs

Other than asking respondents to evaluate the importance of using RRBMs, they could introduce other aspects in an open-ended question. Open coding was used to elicit themes in NVIVO. The results from categorizing these data show that 61% of the responses could still be classified in the three pillars of sustainability while 38% mentioned new aspects that were important for them when using RRBMs. These new categories were personal, aesthetics, and performance. The codes found are shown in Figure 34 and were classified in the three new aspects as well as the sustainability pillars. The frequency of each code is given as a rectangle and the bigger the rectangle, the higher the frequency. Some codes are defined as main categories such as “Aesthetics”, and other codes are placed under these categories, such as “looking good” and “visually pleasing” under the “Aesthetics” category.

“Aesthetics” with a frequency of 49 appearances was an important factor for people. A typical answer coded under “Aesthetics” was “beauty, appearance, looking good, and visually pleasing”. Also, answers to do with finding “rare pieces” and unavailable products by reuse and recycling that affected the look of the building have been included in “Aesthetics”. “Rare pieces” as a subcategory has a frequency of 4.

“Personal” is a code that covers answers like “feeling good, self-satisfaction, humanism, self-identity, personal attitudes, and emotional”. Creativity has also been included in this code as a

subcategory since a considerable number of responses indicated “creativity” and inventiveness driven by reuse and recycling. “Creativity” has a frequency of 10.

“Performance” as the third category with frequency of 18 was mentioned in answers like “higher quality, useful, efficient, harder, better performance, and workability”. “Durability” and “resilience” (as a subgroup of durability) are also placed in the “performance” code with a frequency of 2.

The hierarchy of codes show that “social” aspects are the most important although there are issues, like conservation of history or culture, that people did not think were social aspects. Among these issues around conserving history were the most significant item stated by respondents.

“Environmental” aspects are in second place with a frequency of 60 and reducing waste is not unsurprisingly the most frequent subcategory. What is surprising is that respondents did not count reduction of waste as an “environmental” aspect but added this as another aspect.

“Aesthetics”, “Personal”, and “Performance” came after environmental aspects based on frequency and then “Economic” with a frequency of 15.

Figure 34. Codes extracted from respondents' opinions on the evaluation of RRBMs in terms of different aspects in NVIVO

6.7.5 Conclusion

The environmental aspect is the most important when it come to the use of RRBMs. Different stakeholder groups think the same way when evaluating the importance of RRBMs within the framework of the three pillars of sustainability. This is a beneficial point because there is no need to educate them on the high environmental value of using RRBMs. However, comparing the mean rank that each group gave to the three pillars shows that environmentalists and builders fall at the extreme and opposite ends of opinions. This shows how policies and guidelines around the use of RRBMs should be targeted differently for each stakeholder group. Differences between groups in environmental and social evaluations had the same pattern and this pattern contrasted with the economic evaluation pattern. In terms of socio-demographics, gender and education showed some influence on the evaluations of respondents.

Interpretation of the open-ended survey question revealed that other than the environmental, social, and economic aspects of the use of RRBMS, other considerations were aesthetics, personal issues, and performance of these materials and components in order of priority of importance for stakeholders.

6.8 Promoting environmentally friendly activities

Descriptive statistics show that 65% (397 out of 607) of respondents stated they had participated in environmentally friendly activities related to RRBMs (Table 24). Those who answered yes to this question went on to list the type of activities in which they had participated. Among those who answered yes, 55% were architects and builders. Results show that “assessing environmental impacts” at 32% was the most frequent activity followed by “social movement” (22%), “effective voice” (19%), “creating a network” (16%), and “fundraising” (11%) (Figure 35).

Table 24. Participation in activities by the stakeholder groups

		occupation						Total
		manufacturer	builder	architect	environmentalist	regulator	consumer	
activities	Yes							
	Count	60	118	100	33	33	53	397
	% within activities	15.1%	29.7%	25.2%	8.3%	8.3%	13.4%	100.0%
	No							
	Count	32	32	44	15	12	75	210
	% within activities	15.2%	15.2%	21.0%	7.1%	5.7%	35.7%	100.0%
Total	Count	92	150	144	48	45	128	607

Other than activities given in the list of choices, participants could mention other forms of engagement. Most said they had used RRBMs in building projects that could indirectly promote use of these materials, noting that 55% of the respondents who noted other activities were architects and builders. Other themes were educating other people and doing research in this field. Results of coding these themes indicated that environmentalists had done more educating and promoting, architects were doing more research compared to other groups, and architects and builders were actually using these materials (Table 25).

Figure 35. Share in each type of activity

Table 25. Results of coding themes and frequencies

	manufacturer	builder	architect	environmentalist	regulator	consumer
1: education	1	3	3	4	3	2
2: research	2	0	3	1	2	0
3: use and recycling	26	47	42	6	8	21

6.8.1 Conclusion

The findings of this section indicated that people who were doing activities to promote the use RRBMs were mainly architects and builders and they claimed that by using the materials they were promoting them. Based on the review of websites of NGOs and environmentalists (see section 3.2.), there are not enough activities around the use of RRBMs, compared to the recycling of other products and reducing the use of plastics.

6.9 Regulations and certificates related to RRBMs

Four questions are asked to find out how much stakeholders knew about regulations and certificates related to RRBMs. Results show the most frequently selected option was “neither agree nor disagree” suggesting most did not have enough information about regulations and certificates (see sections 2.2. and 2.3. for information about regulations and certificates). Almost 34% stated there were not enough regulations related to RRBMs while 18% stated the opposite, and 45% said they did not have enough knowledge about these issues while 28% said the opposite. Around 37% stated that there were not enough relevant building certificates while 10% stated the opposite, and 38% said that there were not enough relevant material certificates while 10% said the opposite (Figure 36).

Figure 36. Respondents' attitudes towards relevant RRBMB regulations and certificates

6.9.1 Effect of occupation

Comparing the occupations of the stakeholder groups showed no statistically significant difference for the existence of relevant regulations, but for the other questions there were significant differences. Consumers disagreed less than other groups about the existence of relevant regulations and were among the groups that agree more, showing they thought more positively towards regulations and certificates (Figure 37). However, when it comes to knowledge about these regulations, consumers said they did not have enough knowledge, and this could be the reason behind the previous result. Also, manufacturers and think more positively that there are enough

related regulations and certificates as they agree more than others with this statement. Interestingly, architects claim that they have enough knowledge about these issues more than other stakeholders (Figure 38). More than others, they also felt there were not enough certificates, which was not unexpected because this kind of knowledge is essential for their occupation.

Figure 37. Stakeholder opinions on the existence of relevant RRBM regulations and certificates

Figure 38. Stakeholders' knowledge of relevant RRBM regulations

6.9.2 Conclusion

Based on the responses to these questions, it seems there is not enough information about relevant regulations and certificates, with consumers having least and architects the most knowledge in this area.

6.10 Importance of material specifications

The stage of choosing materials in the process of building constructions has a major effect on the environmental impacts of a building. Choice is complicated as many factors should be weighed up. Among the available materials in New Zealand and based on BRANZ publications such as *Materials* (Conder, 2008), the main factors can be summarised as health, durability, cost, performance, impact, and safety, and these have been used in this study as the basis for the analysis in this section.

6.10.1 Descriptive statistics

The Friedman test compared the mean ranks of health, durability, cost, performance, impact, and safety based on the evaluations of the stakeholders. Descriptive statistics show that the ranks of these six factors were significantly different, with a chi-square value of 274.759, $p = 0.000$. “Performance” was ranked highest at 2.61, following by durability, health, environmental impact, cost and safety at 4.30 (Table 26, Figure 39).

Figure 39. Friedman test results

As performance and durability are two factors related to technical aspects of building it is not surprising they were more important for the respondents. Although measuring the environmental attitudes of the participants showed very positive attitudes, when it came to choosing materials, performance and durability came first, then health and environmental impacts. Perhaps more surprising was that cost was not among the more important factors when it came to the whole sample (Table 26). Consequently, comparing the opinion of each stakeholder group could be beneficial to see if there are any differences.

Table 26. Mean rank of each factor based on the respondents' evaluation

Factors	Mean Rank
health	3.48
durability	3.11
cost	3.94
performance	2.61
impact	3.56
safety	4.30

6.10.2 Effect of occupation

Comparing the mean ranks across the groups revealed the evaluations of environmentalists and builders were different. For performance and durability, which were perceived by the whole sample as the most important factors, manufacturers gave the highest and environmentalists the lowest rank. For environmental impacts, manufacturers gave the lowest and environmentalists the highest rank. This difference could be expected based on the nature of their professions. For cost, builders gave the highest and environmentalists the lowest rank (Figure 40). This is also consistent with expectations, since builders should care about the costs of materials and also the costs of their applications and maintenance.

Figure 40. Mean Ranks of stakeholder groups for evaluation of materials

6.10.3 Conclusion

Overall, performance and durability were the most important factors when it came to choosing RRBMs and safety was less important compared to the other factors investigated. Comparing the stakeholder groups showed that manufacturers gave more value to performance and durability and less to environmental impacts, which is exactly opposite to the evaluation of the environmentalists. Builders also gave more value to cost, which was again the opposite of the environmentalists.

6.11 Stakeholder roles

The first set of questions in this section asked respondents what they thought of the roles of others in “enhancing reuse and recycling of building materials”, “changing attitudes for this approach”, “implementing the use of RRBMs”, “checking the safety and performance of them”, and “including consumers’ ideas in this process”. They were then asked questions about their own roles and responsibilities and their knowledge of the latter.

6.11.1 Perception about the roles of others

Descriptive statistics showed that the most important role for enhancing the reuse and recycling of building materials was the “consumer” at 31% and least important was the “environmentalist” at 1%. For changing attitudes to encourage this approach, the most important role was the “regulator” at 29% and least important the “builder” at 7%. For implementing the use of RRBMs, the most important role was the “architect” at 31% and the least important the “environmentalist” at 1%. For checking the safety and performance of these materials, the most important role was the “regulator” at 62% and the least the “environmentalist” at 1%. For making sure consumers are aware of RRBMs, the most important role was the “architect” at 52% and the least the “environmentalist” at 5%.

Figure 41. Comparison of stakeholders' perceptions about the roles of others

Comparing the perceptions of the different groups of stakeholders about this issue should bring more insight in how each group thought about their own and the roles of others regarding these five questions (Figure 41).

6.11.2 Effect of occupation

Table 27 is matrix to show which stakeholder group could enhance the use of RRBMs based of the perceptions of the stakeholder groups. In Table 27 green circles show the highest percentage in terms of influence, and yellow circles show the next highest percentage for each group. The column labelled “Total” are averages for the whole sample. A black circle shows the highest average percentage and the grey circle the next highest average percent. The group which gained the highest percentage in total is coloured in yellow. These colours are consistent for Tables 27-13.

For the first question consumers were perceived as the group most responsible for enhancing the reuse and recycling of building materials, while consumers, along with regulators and environmentalists believed that manufacturers had the most important role in this process. Manufacturers thought that consumers and regulators were equally important although architects, builders and manufacturers thought consumers were more important (Table 27).

Table 27. Attributing the role of enhancing reuse and recycling of building materials to stakeholders based on their own perceptions

choices	enhancing reuse and recycling of building materials						
Manufacturer	22.2%	16.2%	20.4%	31.0%	30.2%	26.9%	22.5%
Builder	8.9%	7.0%	1.5%	11.9%	7.0%	15.1%	8.0%
Architect	15.6%	18.3%	13.9%	14.3%	14.0%	10.1%	14.5%
Environmentalism	0.0%	0.7%	0.7%	4.8%	0.0%	2.5%	1.2%
Regulator	26.7%	21.8%	24.1%	16.7%	25.6%	19.3%	22.5%
Consumer	26.7%	35.9%	39.4%	21.4%	23.3%	26.1%	31.2%
	Manufacturer	Builder	Architect	Environmentalism	Regulator	Consumer	Total
	stakeholders						

For the second question, together groups agreed that regulators had the most important role in changing the attitudes of others, but environmentalists thought that architects had a more important role. Regulators and consumers thought their groups were as important as each other (Table 28).

Table 28. Attributing the role of changing attitudes toward the use of RRBMs to stakeholders based on their own perceptions

	changing attitudes for this approach						
Manufacturer	12.2%	11.3%	10.9%	7.1%	14.0%	15.1%	12.0%
Builder	8.9%	4.2%	5.8%	11.9%	11.6%	5.0%	6.6%
Architect	18.9%	18.3%	17.5%	28.6%	18.6%	16.8%	18.7%
Environmentalism	7.8%	5.6%	14.6%	16.7%	9.3%	10.9%	10.3%
Regulator	27.8%	33.1%	29.2%	26.2%	23.3%	26.1%	28.6%
Consumer	24.4%	27.5%	21.9%	9.5%	23.3%	26.1%	23.7%
	Manufacturer	Builder	Architect	Environmentalism	Regulator	Consumer	Total
	stakeholders						

For the third question, the total average showed architects had the most important role in using RRBMs, but the answers for each group were slightly different. The regulator group was chosen by manufacturers, environmentalists, and regulators. However, environmentalists think that regulators and manufacturers had an equally important role, and regulators thought they and builders were as important as each other in this. The most frequent choice of architects, builders, and consumers was the architect group, perhaps because these three groups have more direct contact with each other, although, manufacturers, environmentalists and regulators also thought the same way (Table 29).

Table 29. Attributing the role of implementing the use of RRBMs to stakeholders based on their own perceptions

	implementing the use of reclaimed and recycled building materials						
Manufacturer	11.1%	8.5%	8.8%	26.2%	14.0%	10.1%	11.0%
Builder	16.7%	9.9%	5.8%	11.9%	25.6%	16.0%	12.6%
Architect	24.4%	35.9%	40.9%	23.8%	14.0%	28.6%	31.2%
Environmentalism	0.0%	1.4%	1.5%	0.0%	2.3%	1.7%	1.2%
Regulator	35.6%	28.2%	26.3%	26.2%	25.6%	27.7%	28.4%
Consumer	12.2%	16.2%	16.8%	11.9%	18.6%	16.0%	15.5%
	Manufacturer	Builder	Architect	Environmentalism	Regulator	Consumer	Total
	stakeholders						

For the fourth question, everyone agreed that regulators were the most responsible group in checking the safety and performance of RRBMs. This appeared to indicate all groups thought there should be regulations and legal pressure to make them use more RRBMs and ensure manufacturers and suppliers make certain these materials meet the needs of the appropriate standards (Table 30).

Table 30. Attributing the role of checking the safety and performance of RRBMs to stakeholders based on their own perceptions

	checking the safety and performance of them						
Manufacturer	23.3%	17.6%	20.4%	19.0%	7.0%	9.2%	16.8%
Builder	8.9%	14.1%	10.9%	9.5%	4.7%	10.9%	10.8%
Architect	2.2%	10.6%	8.0%	0.0%	7.0%	7.6%	7.0%
Environmentalism	1.1%	0.7%	0.7%	0.0%	2.3%	2.5%	1.2%
Regulator	64.4%	54.2%	59.1%	66.7%	72.1%	68.1%	62.1%
Consumer	0.0%	2.8%	0.7%	4.8%	7.0%	1.7%	2.1%
	Manufacturer	Builder	Architect	Environmentalism	Regulator	Consumer	Total
	stakeholders						

Answers to the fifth question showed all groups of stakeholders thought similarly and believed that architects are responsible when it comes to including consumers' ideas in the building construction process and this would have an effect on use of RRBMs (Table 31).

Table 31. Attributing the role of including consumers' ideas in this process to stakeholders based on their own perceptions

	including consumers' ideas in this process						
Manufacturer	21.1%	11.3%	17.5%	7.1%	9.3%	9.2%	13.4%
Builder	6.7%	10.6%	2.2%	14.3%	18.6%	12.6%	9.2%
Architect	42.2%	57.7%	52.6%	52.4%	53.5%	49.6%	51.7%
Environmentalism	6.7%	4.9%	3.6%	7.1%	0.0%	5.9%	4.9%
Regulator	15.6%	8.5%	15.3%	16.7%	14.0%	10.9%	12.7%
Consumer	7.8%	7.0%	8.8%	2.4%	4.7%	11.8%	8.0%
	Manufacturer	Builder	Architect	Environmentalism	Regulator	Consumer	Total
	stakeholders						

6.11.3 Stakeholder responsibilities

Stakeholders were first asked whether they accepted they had a role in enhancing the reuse and recycling of building materials, to which 56% answered "yes" with only the consumer group averaging "no". This shows that all of the main stakeholders knew they have a role in changing this situation in the building industry, which is a positive point from which to start change. This also suggests there should be more thought put into making consumers more environmentally responsible when it comes to using RRBMs.

For the more detailed questions about their knowledge of responsibilities, descriptive statistics show that 63% of respondents said they did not know the roles of other stakeholders, although the manufacturers/suppliers group stated they did know about the roles of others. Most respondents (70%) said they had no knowledge of regulations in their occupation related to the use of RRBMs and all groups of stakeholders thought similarly. That said, they mostly (64%) agreed their

occupation had an effect on increasing the use of these building materials, except for the consumer group. Also, based on their professional responsibilities, the majority of respondents (71%) agreed they should use these materials, and this was the same for all stakeholder groups. Surprisingly almost all (92%) stated that they should suggest others also use these materials.

6.11.4 Conclusion

As seen in the results, regulators and architects are two key stakeholder groups that could influence change regarding the use of RRBm, with consumers in third place as the end users. Comparing the results between groups indicated generally stakeholders do not think the same about their responsibilities and try to push these responsibilities to other stakeholders, especially in cases when there are no clear regulations. Also, they do not have enough information about other responsibilities of other stakeholders. Despite this, the majority of stakeholders, with the exception of consumers, knew they had a role in increasing use of RRBm.

7 Focus groups and interviews

7.1 Sampling

The size of the focus group should be small enough for all participants to have a chance to talk and large enough to cover different perceptions. The homogeneity of the group is important but should be based on the purpose of the study. In the focus group, as in real life, participants influence others and are influenced by them, which presents a natural environment (Krueger, 2014).

The ideal size of each group with a non-commercial purpose is six to eight participants; however, mini-focus groups with four to six participants are valid and these are easier to recruit and control for the moderator and more comfortable for the participants (Krueger, 2014). In this study mini focus groups were conducted according to the number of available respondents, time and resources.

Homogeneity in a focus group means participants having something in common, and when searching for similarities and differences between groups, it is best to have a series of groups of each type (Krueger, 2014). The original plan in this research was to have one focus group with each group of stakeholders, but this changed a little according to the circumstances (see section 10.4).

In the qualitative process of data collection, the number of participants can be determined by the notion of saturation. Saturation means a point at which no new information is discovered (DeCuir-Gunby & Schutz, 2017). In this study, the sampling strategy is stratified sampling. For exploring a smaller group of participants from the quantitative phase, a subset participated in the qualitative phase from indicating they were willing to participate at the end of the online questionnaire.

Willingness to be part of a focus group was indicated by 250 people. The focus groups consisted of two groups of architects (one pilot group of six, one group of four), one group of four consumers, one group of three regulators, and one mixed group of five builders, environmentalists, manufacturers and suppliers. The group of regulators was conducted as three separate interviews due to the difficulty of arranging an agreed time and location for them.

7.2 Data collection

Personalized invitations were sent to all of the contacts between two weeks to one month before the planned session (Krueger, 2014). In the invitation letters, potential participants were asked to note their occupation to filter them for making groups. If they still showed a willingness to participate in the focus groups, a description of the project and plan of the meetings was sent to them in order to arrange the time and location.

All of the sessions, except for the regulators group, took place in the School of Architecture. For regulators, a place near to their office was arranged so they could use their lunchtime for the interview. All of the sessions were voice recorded, and one note taker was present as backup data collector for the focus groups.

Each session took 1.30-2.00 hours depending on the number of participants and refreshments were provided during the session. Before starting the focus group, a consent form and the ground rules of the group were given to participants and discussed to ensure that everything would be confidential. Participants could leave the group anytime they felt they were not happy to continue, and they could use pseudonyms instead of their real names if they wished. The same rules were applied to interviews for the regulators group who could attend one group and ended up in three separate interviews.

This phase of the research was approved by the Victoria University of Wellington Human Ethics Committee 26502 (see Appendix 5). The HEC approved the variation from focus group to interviews.

7.3 Qualitative discussions

7.3.1 Design of the discussion

Focus groups can shed light on quantitative data. Kruger (2014) defined the intent of the focus group as “not to infer but to understand, not to generalize but to determine the range, and not to make statements about the population but to provide insight about how people in the groups perceive situation”.

The purpose is not to reach a consensus, but to understand feelings and comments in the discussions; in other words, to see the issue through the eyes and hearts of participants in an interactive environment. Focus group are run to understand differences, uncover influential factors on behaviours, opinions and motivations, and to find the synergy that does not happen in individual interviews, specifically for complicated topics. Participants may not know detailed and specific information about the topic, but they can share their perceptions and this is rich information for the study (Krueger, 2014).

7.3.2 Questions

The questioning route is set up to give structure to a focus group, and normally as the group continues the questions become more focused. Developing the questioning route is based on the nature of the questions and the cognitive processes of participants. The natural flow of questions from broad and general questions to more focused important questions is the question sequence, starting with opening and introductory questions, continuing with the transition and key questions, and concluding with winding-up questions. The responses of each participant spark ideas from other people in the group. The informal environment of the group helps respondents share ideas some of which work as mental cues that trigger memories or thoughts in others (Krueger, 2014). Different questions should be asked in each group according to their expertise regarding RRBMs, but a core set of questions should be the same (Table 32,

Table 33).

Before starting the focus group, the rules of the group, the information sheet and consent form were given to the participants (see Appendix 8, 9, 10)

To commence the focus group and get people to talk, the researcher started with asking their name and why they are interested in this topic. In order to introduce the topic and get them thinking about it, the researcher asked them their opinion on the idea of using RRBMs in New Zealand and then asked more detailed questions depending on the occupation of the group. The focus group discussions took 90-120 minutes.

Changing the environment of the focus group from introductory to key questions can be facilitated by using specific, in-depth questions. At this stage, slides were used to introduce the different categories and opportunities available in New Zealand to take advantage of RRBMs and participants were asked to give their opinion on the use of these materials.

Key questions need greater attention and take more time than other questions. After the slides questions were raised about policies, guidelines, certificates, and appraisals to make the discussion a bit more serious and prepare participants for the main questions, which were the results of the online questionnaire. While presenting these results participants were asked for their opinion on the reasons behind them. Asking participants to offer their reasons is a great advantage of the focus group.

Bringing closure to the discussion was done by reflecting on previous comments and finding the final position of participants, together with interpreting conflicts that emerged during the session.

Table 32- Questions for the focus group of architects

Opening questions
1. What is your name?
2. Why are you interested in this topic?
Introductory questions
3. To begin, could you please outline your opinion about the idea of using reclaimed and recycled building materials in New Zealand?
3.1. How would you proceed to use these materials in the project? How do you find the information you require? What are the differences in the process of using these materials and conventional ones? If you think there is no place to use them, what are your reasons?
Transition questions
4. Which of these materials do you prefer to use in a project based on the appearance and specifications? (PowerPoint of materials)
4.1. What are the reasons behind choosing and not choosing these options? What are the barriers? What can be done to change (increasing the use of these building materials and products)?
Key questions
5. Which policies, guidelines, certificates, appraisals or publications do you need to consider when using reclaimed and recycled building materials?

6. These are some of the main results of the survey (PowerPoint of results). What do you think may explain the reasons behind them?
Ending questions
7. Did I correctly interpret what was said? (giving a summary of the discussion)
8. Is there anything that we should have talked about but didn't?

Table 33- Questions for the focus group of other professions

Opening questions
1. What is your name?
2. Why are you interested in this topic?
Introductory questions
3. To begin, could you please outline your opinion about the idea of using reclaimed and recycled building materials in New Zealand?
3.1. What are their advantages and disadvantages? If you think there is no place for using them, what are your reasons?
Transition questions
4. What are the reasons behind choosing and not choosing these options? What are the barriers? What can be done to change the situation? (PowerPoint of materials)
Key questions
5. Which policies, guidelines, certificates, appraisals or publications are you aware of or consider when choosing reclaimed and recycled building materials?
5.1. Which ones are necessary to consider? Which ones are just helpful or informative?
6. These are some of the main results of the survey (PowerPoint of results). What do you think may explain the reasons behind them?
Ending questions
7. Did I correctly interpret what was said? (giving a summary of the discussion)
8. Is there anything that we should have talked about but didn't?

7.3.3 Pilot

After phrasing and sequencing the questions, feedback was obtained from people with a similar background to the potential participants. In a focus group, the sequence of questions is an essential characteristic because it is sensible for the audience to move from general to specific questions and thus give them this chance to build their perspective based on opinions discussed earlier. Enough

time should be given to each question so as to not to gather superficial information. It is useful to note that experts normally have more to say than non-experts. In addition, test the questions can help to see that they flow smoothly and are not confusing. Although there is the opportunity to revise the question sequence after running the first group, it is better to maintain consistency because it is in the comparison that themes and patterns show up (Krueger, 2014). For this reason, a pilot focus group was run with a group of architects. The changes made after this first focus group concerned giving more explanation when presenting the main results of the survey and making minor changes to the appearance of some slides. Presentations are provided in Appendix 1 and 2.

7.3.4 Data management

Preparing the data of this phase of the study means transcribing the recorded voices. Exploring the data is the first step in having a general understanding, then themes can be developed. Finding themes is a translation and summarization of non-numeric, text answers. So based on the comprehension of the researcher, words, tone, and intended meanings were converted to themes and categories (Groves et al., 2011).

The data analysis starts by coding and finding themes. After finding clear definitions for each theme, data can be presented as diagrams and relationships will be revealed. By grouping evidence, broader perspectives can be seen in the final report (Hopwood, 2006; Vaismoradi, Turunen, & Bondas, 2013). The procedure of this analysis will be explored further in the next chapter.

8 Focus groups and interview results

8.1 Introduction

The exploration of ideas is both the initial and the most challenging step in analysing qualitative data; data do not speak for themselves (Richards, 2015). The data collected in the focus group discussions were processed using the thematic analysis techniques. Thematic analysis helps to find a patterned meaning across transcripts. This is a popular and flexible method to analyse qualitative data. There are different steps to find the pattern and it is needed to go back and forth between steps; however, there are not rigid rules (Clarke, Braun, & Hayfield, 2015).

There are some general guidelines, but there is not any that fits all research topics. It should be a systematic and thorough process. Following the main steps leads to more valuable findings and a more meaningful pattern (Castleberry & Nolen, 2018).

These general steps have been explained and the results of each step have been provided as follows. Quotes were first extracted from the transcripts, then codes were generated based on these after becoming familiar with the text. The codes extracted from the text were placed into different categories and subcategories using different colour highlights (Figure 42).

architects are more accurate in responding to this question than other groups. They should know if there are any regulations. Results make sense.

shows the level of concern, manufacturers care about profit, architects do.

with regulators and ... have high score, they have the mean to force others.

between ones show where research is happening, but we do not have a right to share the results, we do research but it is not transferred to other parts of the industry.

manufacturers produce materials so they are using resources, and pay money. Builders and manufacturers almost think the same way, they have clear aspects of actual practise.

like solar panels, production is bad for the environment, but manufacturers.

the position of consumer and manufacturer doesn't change, changes happen in the middle. The groups in the middle follow others, the problem is in the middle.

disagree, consumer say I cannot get enough information! They need some.

Figure 42. An example of highlighting codes for classifying into categories and sub-categories (the picture only shows the method, with purple showing categories, cyan subcategories, and green examples).

The aim was to create a model to show what was going on in the data and to summarise the key issues of interest to each of the stakeholder groups. This model would then shape a network of codes to find the more prominent ideas (Laycock et al., 2016; Richards, 2015) (Figure 43). This was done across the one pilot group and the three groups of architects, regulators, and consumers. These groups emerged from the quantitative data in the first phase of the study as the most important in terms of their ability to increase the uptake of RRBMs. The initial aim of classifying codes was to find common themes and differences across groups in order to identify challenges and opportunities.

The first step was classifying themes that emerged from the pilot group as part of testing the method to ensure there would be meaningful outputs. This produced a basic tree of themes and codes that became the initial thematic map (Figure 44). This tree was simplified to the final thematic map. This map was then checked to see whether the ideas or relationships that had emerged were of benefit to the study. All other focus groups were analysed in the same way to find the big picture and to look for commonalities. Ideas become more complex and at the same time more confident through analysis of all groups (Laycock et al., 2016; Richards, 2015). The extracted codes from each group were tested to see whether they fitted the thematic map and its classifications, and when needed, the thematic map was revised.

8.2 Procedure

The analysis was not a one-pass process as the data had to be revisited until patterns were revealed. This type of qualitative coding is not a mere labelling of topics, as the goal is to reflect on the codes, how they relate to ideas (challenges and opportunities), and how they can be understood as patterns through making categories. Challenges and opportunities were two of the first headings to emerge in the thematic map, and are shown in yellow and green in Figure 43. After highlighting the codes in the transcripts, and classifying them in categories such as challenges, opportunities, and regulations, all codes and categories formed a network. These categories were in different colours (yellow, green, blue, and grey) since they had different natures. In the next step these categories were classified into a hierarchy and codes were revisited so as to be in the right category. Figure 44 was then developed based on Figure 43.

After creating the first tree of themes, each focus group transcript was coded, and newly discovered themes were added to the same tree to develop it and to check if the categories were still meaningful for the new group. It is also necessary to see categories from different viewpoints, so a theory can be constructed about relationships between them. As a result, a top-down and bottom-up approach was used to simplify the model of relationships.

In this chapter, the results of these classifications and coding of each group are reported and then commonalities and differences are discussed. After summary of the results of all groups, the big picture is shown from a different point of view and discussed with regard to the literature.

8.3 Pilot focus group

The pilot group was run in the Faculty of Architecture and Design, Victoria University of Wellington. The six participants were all architects and PhD students of Architecture (international and domestic) who had worked in their own countries and were registered. This focus group was held in a meeting room at the Te Aro Campus and lasted for an hour and a half. The first model of the results of this group was created to show the categories, with the purpose of using it as a base model for the next groups. The pilot focus group also gave the opportunity to revise the questions and presentation if any errors, misunderstandings or lack of explanation appeared during the focus group.

The pilot group was conducted with six participants who had answered the online questionnaire in the first phase. The discussion explored their responses to the idea of using RRBMs in New Zealand, their preferences for materials, and the policies, guidelines and certificates related to RRBMs. The conversation also probed the reasons behind the main results of the online questionnaire. The detailed questions for the focus groups were given in section 6.1.3.2. Questions did not change after the pilot group, although some presentation slides were modified to present the data in a better way.

As the discussions flowed across the topics of the individual questions put to the participants, codes did not emerge in relation to each predetermined question, but rather to key themes. This was why all focus group discussions were treated equally so as to find the codes. These themes were main challenges or opportunities, and included *materials, stakeholders and regulations*. The rest of the codes were put into these categories (Figure 44).

Figure 44. Initial thematic map from the pilot group of PhD students of architecture

8.3.1 Materials

Discussions on materials revolved mainly around their characteristics, availability, behaviour and relevant information. Some of the main concerns of participants were the challenges regarding the use of RRBMs such as this being a *“time consuming”* process, both in finding them on *“construction sites”* or doing *“research”* into them. Participants also noted some RRBMs were in the *“red list”*, so their reuse is questionable. Other comments relating to materials included less *“financial benefit”*, the ease of using *“routine materials”*, the state of their *“look”* or *“texture”*, physical or technical characteristics or performance like *“weather tightness”*, *“acoustic behaviour”*, *“resistant to earthquake”* and *“weight”*, and only being suitable for specific purposes like *“temporary structures”*. Having a *“tendency”* to use them or passion for the environment were aspects that might encourage their use, while lack of *“knowledge”*, *“information”* or a *“database”* were other reasons behind their underuse.

8.3.2 Stakeholders

Stakeholder issues were attributed to the types of stakeholder, although there were perceived to be common issues between stakeholder groups such as a lack of knowledge, social and global pressures to save natural resources and generate less waste, understanding the financial benefits of using RRBMs, and lack of communication. Figure 44 shows that most comments are around the responsibilities of architects.

In the discussion of the results of the online questionnaire, the pilot study members generally talked about the growing concern for sustainable solutions leading to high scores on the NEP scale. They saw these scores as an indicator of positive environmental attitudes; *“all of them have high scores”*, *“...It shows the trend”*, and *“very high level of awareness of everybody”*. However, they also said *“...most of them are conservative”*, meaning people usually try to show themselves as more environmentally friendly as being this is expected of them because of their occupations, such as being regulators in this field, even if this is not reflected in their actions. The focus group discussed the role of architects more deeply with statements like, *“...the world is paying attention to sustainability and architects should think about the materials and how to get rid of the leftovers...”*, *“...to find the design solution and to inform*

stakeholders...”, “...They need to go to the city council, they should know if there are any regulations”. There was some disagreement in defining the responsibility of architects. One participant said “*This is the architects’ role to find the information...*” but there were other attitudes regarding information like “...We look for more information, and creative ways of using things, but in this case, information needs to be there...” or “...how to reuse them and check the specifications...” but “...we cannot check everything”, “We always refer to the specification given by manufacturer”. They mentioned creativity as one of the characteristics of architects that could play an important role here; “...there are materials other than building material found out there that architects can reuse.”

Later in the discussion of the reasons behind the online questionnaire results, they talked about the close connection with clients; “...talk to clients, ...talk to them that why we are using these materials...”, “...architects need clients to ask them to do”, “encourage them...for choosing materials, it highly depends on architects.” They said that clients “...just think about cost and look rather than environmental issues”. Participants thought that manufacturers face the highest risk in this chain of stakeholders; “the first step is manufacturing, they have to take the highest risk in this chain, they cannot guarantee the market demand”, “they should be careful about investment and return”. They also believed that because of the close relationship between architects, builders and clients they would have similar opinions and environmental attitudes, noting that “...they stay close to each other” when it came to the NEP scores, while the environmental attitudes of environmentalists, manufacturers and regulators had differing scores in the online questionnaire. Members of the pilot focus group thought regulators would have a role here to “...make a bridge between groups...to achieve environmental goals”, and they “...can reconcile these groups”, as well as having “...the means to force others”.

One of the ideas that emerged was that the environmental attitudes of survey respondents had a close negative relationship with money; “...the whole spectrum can be seen in terms of cost” with the implication that those for whom money is more important care less about the environment. Some focus group participants looked at differences in environmental attitudes in terms of their hierarchy; an example given being the architects’ NEP results compared with those of builders and manufacturers; “...how different groups look at the hierarchy of their groups, like how builders look at architects, they listen to architects, architects try to keep

everyone happy, manufactures think that they are above architects because they should go and buy materials from them...”

The discussion also addressed a problem which is common for all stakeholders, namely the “*lack of connection*” between them “*...research is happening, but we do not have a right communication to disseminate the results, we do research, but it is not transferred to other parts of the society.*”

8.3.3 Regulations

Challenges related to regulations were more focused on compliance with the building code and city council consent. The group thought that finding relevant policies and guidelines was difficult; “*... I have not found anything from the city council for using recycled building materials...*”, “*...City council is an important stakeholder to put some policies.*” Regarding the building code, they believed that “*...Building code talks about specifications of materials not specific materials to use...*”, so if the chosen material complies with the building code then it can be used, but the big gap here is that “*...materials should have certificates from BRANZ...*” and RRBMs do not have these. Some participants thought differently as they believed an architect can “*...introduce a new material or new use of it. This is the responsibility of producers, manufacturers to go to BRANZ to get the certificate. Architects can go to the manufacturers and ask them to get that.*” They also felt some building certification schemes like LEED, BREAM or Greenstar (see section 2.3.1) could “*...encourage...*” this approach.

8.4 Results of the main stakeholder focus groups

After running the pilot focus group, everything was checked in terms of discussion topics and questions, required arrangements and the management of the session. A basic initial thematic map was created to simplify the classification of extracted codes. This thematic map changed based on emerging new ideas and relationships that emerged from analysis of the remaining groups. However, this process was repetitive, and reviewing the transcripts revealed new concepts in the relationship model.

8.4.1 Architects focus group

This focus group consisted of four architects. The session lasted for an hour and a half and was held in a meeting room in the Te Aro Campus of Victoria University of Wellington. Extracted codes were classified into the three main themes of materials, stakeholders and regulations (Figure 45).

8.4.2 Materials

The architects thought that one barrier was time, since it takes time to reuse materials, to *“...make it fit, make it appealing to the client...”*. Some group members thought that certain factors would make RRBMs more interesting for clients; *“sometimes people love the story behind these recycled materials...”*, or the feeling that these materials give them; *“...when it is rustic it is a really good thing this rustic feel”*. However, others in the group thought it was not just about the look *“...aesthetics...society has an obsession with newness, it depends on the cultural context.”* They felt this was *“...a big social issue”* and could be why *“...most designers do not want to take a chance on these materials.”*

Figure 45. Thematic map based on the results of the architect focus group

Some components were felt to be easier to reuse; *“windows and doors are really easy to reuse”*, but still there were common problems like *“...space for keeping them in site...”* It was felt there was a need for *“infrastructure”* for the process of collecting and disseminating RRBMs. The availability of materials and the required infrastructure to make their use easier and faster were discussed *“...took a lot of time and hard to find the right material...”* They also thought it depended on the *“context”*, in terms of the type and scale of projects; *“in large project architects can do some measurements but not in other projects it takes time”*. The purpose for which RRBMs might be used was also important since they could be used more in the *“interior”* of a building.

However, they all believed that *“...everything is determined by the price”*. Another perceived barrier against the use of RRBMs was that people might think *“it is a huge greenwash, we do not know the process”*, so knowing the lifecycle assessment of materials and transparency of information could partly remove this barrier. Making trust was felt to be difficult; architects and clients should be able to trust material characteristics; *“they [referring to materials] are full of propaganda about their goodness and recycledness and durability”*, but as they said they *“...can trust few of them [manufacturers]”*.

8.4.3 Stakeholders

As the group members were all architects with considerable experience, most of the discussion was around architects and how they deal with the use of RRBMs. One dominant idea was that architects have a leading role in deciding to use them *“...a lead decision-maker with your client...”*, however, they also thought *“...creativity plays a huge role...”* here.

They thought generally it was beneficial to reuse and recycle depending on the economic issues and such materials being available, *“...if you are an opportunist, we all are, you see opportunity in reusing materials...”*, *“...it is the smartest way to do recycling and less challenged.”*, *“find materials on the site is the easiest way...”*, *“it is profitable according to the population and resources...”* They also felt doing this was a time-consuming process, so they should be *“patient to use it”*. One of the members was against this whole idea as

“environmentally it does not make sense, even cost-wise” and he/she said that regulators support this approach because *“they do not spend anything”*.

The relationship with clients was felt to be a critical factor because *“the client should be on board, because you need cash and liability”*. They felt the manufacturers should pay to do research on materials, consumers and market demand, because they care what consumers want and whether they have a *“positive attitude towards”* this approach as *“...it is demand-driven.”*. Group members confirmed that *“clients are conscious”* but they need *“certainty”* about material characteristics.

Some members said that it was also important to have good communication with other stakeholders; *“it is necessary also to have some builders on board...”*, or with demolition firms because *“we cannot get to these buildings early enough before demolition contractors, sometimes”*. One of the stakeholders felt to influence architects was the *“...engineer...not only structural”* as engineers have a different perspective to architects, they *“give quantitative data”* and make decisions based on that.

The group also felt one of the reasons behind manufacturers’ low reuse and recycling in their personal life and the high NEP score for regulators was that *“they watch so much material become wasted because of the industry that is why they do not do recycle, regulators make rules, so they think it is important.”*

8.4.4 Regulations

They group believed that *“passing the council is a real problem”* when it comes to the use of RRBMs. Based on what they said, they *“have not come across any of these materials in appraisals of BRANZ”*.

Members of the group stated that *“reuse is a requirement of Greenstar”*, but *“it is a tiny subset of getting certified”* and can easily be ignored.

Consequent to the discussion on the results of the questionnaire, they added that when *“the central government say something...everything changes, suddenly everyone does something...”*, and this was why regulators have a key role in promoting the use of RRBMs.

They also felt environmentalists had a role here to *“inspire regulators.”* One important aspect accentuated by one member was that government and environmentalists always focus on recycling *“...plastic, but not other materials.”*. They said *“politicians need to be brave”* and pass regulations and guidelines for RRBMs.

8.5 Interviews with Regulators

Three regulators were interviewed separately at their workplace each for one hour since it was difficult to arrange a group discussion. The outcome of these interviews was put into the thematic map after their transcripts were analysed separately (Figure 46, Figure 47, Figure 48), and then merged together (Figure 49). Interviewees are called R1, R2 and R3 to make their statements separate.

8.5.1 Materials

R1 felt there were difficulties in reusing building materials as they were *“damaged”*, had *“...old fashioned standards, in terms of its dimensions...”*, the process was *“time consuming”*, and such materials were usually not good for *“structural”* purposes, especially in the New Zealand context regarding weather and insects. An exception was some types of timber that *“...become stronger with age”*. All RRBMs should also have a *“material safety data sheet”*.

R2 said that *“aesthetically”* RRBMs will add something to the building, but *“structurally”* may have disadvantages. Since she/he had done some research on lifecycle assessment she/he could comment on the carbon footprints of refurbishment compared to demolition, stating the *“...environmental impacts of refurbishment are much lower than demolishing the building and restarting it...”*

A common comment among all was that *“cost is everything”*, but R2 and R3 had the experience of reusing building materials and components for their own home for cost reasons, and they thought for this, cost was *“a big motivator especially at the residential level”*. As R3 said, reusing or repurposing was more *“cost-effective”*, and RRBMs were becoming more *“fashionable now”*, like the *“rustic look of logs”* used as a wall in a cafe. Good

potentials for reusing materials were as “*cladding, paving...roofing*”. Overall all three regulators admitted the advantages would outweigh the disadvantages.

Figure 46. Thematic map based on the first regulator R1 interview

Figure 47. Thematic map based on the second regulator R2 interview

Figure 48. Thematic map based on the third regulator R3 interview

Figure 49. Merged thematic map of regulator interviews

8.5.2 Stakeholders

The interviewees agreed that *“New Zealanders are becoming much more environmentally aware...”* and there is a *“a big shift in the general attitude.”* They all felt there was an awareness, and R3 said *“climate change...population growth and...pressure on utilities is mainstream now”*, so it was easier to *“communicate environmental goals”*. For example, R1 said that it had become easier to *“discourage people away from single-use plastic bags”*. However, they also felt the fashion was somehow against this approach as people wanted something *“innovative and new and different”*, so if the fashion swung to environmentalism, everything would be easier. R1 said of RRBMs *“we have to wait a few years to be able to get people to understand recycling”*.

R1 felt the problem is not always lack of information, since there is *“too much information out there”*. In other words, there is a *“definite networking gap”* between stakeholders, so they cannot see the required information. In their view, if *“councils continue to work in silence, we will have this problem forever, we need to have conversations with all the people together, and we all go for it together”*. Consequently, they all agreed that this change of mind-set should happen and R3 said it should happen for *“...the whole building industry ..., the designer, the architect, the builder, they may hopefully influence suppliers, but currently there is a lot of dominance of the whole industry by the suppliers...”*.

A way to influence people suggested by one interviewee was to communicate with people in their own words with the help of *“ordinary people”*, *“away from experts and specialists”*, by using more *“images, visuals, infographics and video clips”*. They all believed that changing the *“mind-set”* of people would be key but that cost also had a significant influence. R2, who was researching waste reduction, was interested in the *“social aspects”*, and she/he thought this might be a route to motivate people to reuse and recycle. As the questionnaire results showed a high NEP score for all groups, R3 thought *“we are a little bit on a turning point, appreciate the closed-loop recycle, how we can reuse certain products, and it is driven by the consumer, consumer has a big influence on top of the design and construction.”* Contemplating these results, R2 also said: *“architects and regulators, probably work around policy...in their workplace...and this will motivate them for personal life”*. R3 felt environmentally friendly behaviours are in the *“mind-set”* of those in related professions, so they would also act the

same at home, like the *“regulators”*. R2 also said it *“...is the architect who works from start to the build”* and that is why they thought environmentalists could pitch in here and help architects because architects are the *“primary advisor of consumers”*, although R3 felt that environmentalists were not *“... really well acknowledged, [and] once they teamed up with regulators it can work”*.

The interviewees felt that *“manufacturers are selfish...”* because they want to *“...sell more”*, so studies would do better to be *“consumer-focused”*. R2 thought action *“needs to come from the top to influence manufacturers, who then comes down to builders”*. One interviewee noted that using RRBMs, *“you are potentially taking some of the business from them [manufacturers]”*. They felt there was a lack of a *“coordinated”* buying and selling network for RRBMs in New Zealand. They believed it was possible to have a *“lifecycle assessment and environmental impacts declaration”* and this would make their purchase easier, as R2 said *“people pick the easiest option around, one that they know”*. R3 also stated that most building materials are not produced here, but dumped here at the end of their life; *“...we do not produce a lot of materials here, and they are imported.”* He/she felt it would be really good to look at *“locally produced materials”* and felt there was a future for recycled products, since *“...plastics cannot get shipped off to sea”*, and that RRBMs should compete with *“cheaper materials”*.

R1 said builders know the *“practical side...from experience”* so were a kind of *“in-between person”* between clients and architects, but they might also have a *“negative experience to contribute”* regarding the use of RRBMs. R2 also stated *“it is not convenient for builders to incorporate this and talk to clients about these kinds of things...”* as it takes more of their time. They felt architects and developers might want to use innovative ways and new recycled materials but *“...they should be worried about the compliance”*.

One of the problems mentioned by R2 was that demolition companies *“...do not care about saving materials, and deconstruction is a lot more expensive”*. They felt such companies needed to check the *“financial feasibility”* and *“time constraints”*, and they could learn from previous projects for estimating the cost of demolition with reclamation in mind. R1 stated it is always *“easier to build from a clean site rather than renovate.”*, but there was a need to *“rethink how our construction benefits.”*

8.5.3 Regulation

Structural safety is very important for councils as R1 stated they *“pick up the cost of this failure”* and this happens quite often in NZ. This was because even when there was *“insurance”*, businesses *“go bankrupt”*, and this was why *“...councils end up to be so conservative”* and were sometimes hard on people when it came to giving building consents. R1 felt people complain about the *“cost of compliance”*, but that *“risk and money go hand in hand”*.

R1 also stated that the environment in NZ is challenging, in terms of rain, wind and earthquakes, and he/she was *“worried about the BRANZ proofing system”* for building materials, adding that *“BRANZ is specifically for some sorts of characteristics not sustainability”*. However, manufacturers should have *“got all the tests from BRANZ”* and their *“thorough material safety data sheets”*, and that *“REBRI was extremely well-positioned”* to do this work in terms of checking RRBMs. This same interviewee thought there was a need for specialists, such as *“material scientists”* to do *“tests on-site”* when required. R2 identified a barrier to using RRBMs was that *“they have not been yet through that certification and regulation, maybe they need to go through”*,

R1 felt the good news was that *“new rules for waste management is coming”*, but *“It depends on how strong the councils, decide to be...”*, because they *“...want to be re-elected.”* They identified a hierarchy of acts and regulations; first being the *“Local Government Act, then Waste Management Act, then Regional Waste Minimization Strategy, then each council has a strategy”*. R1 felt there was a culture in New Zealand by which people try *“to push boundaries”*, so there should be *“law enforcement”*. R2 also added *“I guess the only way for people to be interested in that, is [for it]to cost more to dump a load of their household waste, that is going to get people interested in a kind of high-level stuff”*. R2 thought that *“no innovation happens unless there is crisis or regulation, kind of for waste”*, and it needed to be regulated for innovation to really take off. R2 added that it was *“so easy at the moment, to not do this”*; R1 also said that *“If a regulator forces it, consumers would become more aware of it through other channels...builder and architect.”* R1 felt regulators needed to be able to *“incentivise you to be able to do that by increasing the waste levy”*. They all mentioned it is cheap to dispose of waste in landfills, and there could be some *“...restrictions...at construction*

sites...". R3 said that being serious about reducing waste needs *"incentives and disincentives at the government"* level, like a *"waste levy...that is how people respond; if it is expensive to dump waste especially, building waste, then people would be more careful about what they dispose of"*. R3 felt this related to other stakeholders as *"if the waste levy increases, the architect, the builder and the building owner would be very conscious of minimising building waste and using sustainable products"*. They felt *"Product stewardship"* could support RRBMs to make them competitive with other conventional materials.

The regulators felt a big concern for councils is that *"C&D waste as a big quantity waste, goes into either regulated or unregulated landfills."* New Zealand no longer sends some types of waste to Melbourne and China, so infrastructure was needed to deal with this waste, possibly through *"remanufacturing"*.

8.6 Consumers (focus group)

The group of four consumers interested in RRBMs came from different backgrounds. The one-hour thirty-minute session was held in a meeting room in the Te Aro Campus of Victoria University of Wellington. Codes were classified into the three main themes of materials, stakeholders and regulations as for the previous groups (Figure 50).

8.6.1 Materials

The cost of RRBMs was the primary concern of all participants, although other factors like durability, safety and health were discussed. Two participants had the experience of repurposing timber and plastics into new tables for their restaurant because of the high price of the latter, or reusing old furniture outdoors. They were also familiar with opportunities for using RRBMs. They knew recycled aluminium saved energy, and savings could be made by *"mixing concrete and plastics"*. They generally thought RRBMs were only suitable for specific purposes like *"outdoor furniture...partitions...and flooring"* and were not sure if RRBMs would be good for structural purposes. Participants talked about the need for material labelling so

as to know “...*what it is made of and check the specifications*”. However, as they said priorities could be different when it came to choosing each material.

8.6.2 Stakeholders

They all agreed that the public attitude was changing to one of being more environmentally conscious as “...*it has become an everyday topic*”. They thought RRBMS could have commercial advantages for producers. They stated that because producers know the “*real challenges of making recycled materials*” their opinion was a bit different from that of other stakeholders in the questionnaire results, as they should be “*sceptical*” about bringing these materials to the market and they needed the support of regulators.

They believed that people “...*have their mindset according to their profession*” so would have answered the questions and behave based on this mind-set. However, they felt this situation was like a “*blaming game*” in that everyone pushes the responsibility and blame to another stakeholder, and they thought the results of the questionnaire and the difference in answers of the different stakeholders show this problem. However, they believed “*there should be collaboration, ...interaction...and network...between them.*”

It seemed they expected environmentalists to have a role here to “*educate people*”, and they expected manufacturers to give more transparent information; “*manufacturers should let the people know about their products, and what they can do with products at the end of life.*”. Also, they said “*manufacturers should test the materials, so architects can use them*”.

At the end, one participant believed that the consumer was the most important stakeholder when it came to improving this situation because when it comes to decisions the consumer “...*is the last person*”. However, the other three believed the architect was the most important stakeholder because the architect is “*the one who has knowledge, consumer doesn’t have it.*” Participants also suggested advertisements and movies have a role in increasing awareness.

8.6.3 Regulations

Members of the focus group said that although the media talk about environmental issues, they do not have enough knowledge to comment on regulations for the reuse and recycling and disposal of building materials. They thought the questionnaire results of the regulator group were different because regulators were more aware of environmental issues and regulation changes and that affects their behaviour.

Figure 50. Thematic map based on the consumer focus group

8.7 Common themes

The aim of comparing the analysis of the discussions of architects and consumers and the interviews with regulators was to look for differences in their attitudes and concerns as regards finding opportunities to improve the uptake of RRBMs.

8.7.1 Architects and Regulators

Figure 51 shows that common ideas as well as differences emerged from both groups of architects and regulators. In the figure, blue shows the codes common for both groups and purple the different ideas of regulators that were not seen in the architect group. Apart from discussion of the characteristics of materials, they all said cost was the most important factor, and that the lack of availability of items was also a big problem. Both groups talked about the importance of finding locally produced materials, and could imagine a better future for materials because of fast-growing technologies.

They thought that builders were better advisors in terms of the practical aspects of using RRBMs. Both groups felt consumers were more attracted to the appearance of materials and that fashion played an important role here, so consumers needed information to make them aware and knowledgeable about RRBMs. Both groups agreed architects had the most important role of integrating these materials in the design process, and making a conscious decision regarding the lifecycle impacts of RRBMs. Architects and regulators accepted that manufacturers take the highest risk in producing recycled building materials and there needed to be a suitable infrastructure for doing this. They stated environmentalists could have the role of lobbying regulators, and the regulators thought that they were not sufficiently acknowledged so as to have a strong voice.

Both groups acknowledged there is social and global pressure towards using RRBMs, especially in more affluent societies like New Zealand, but that the financial benefit was a barrier. They suggested sending less waste to landfills could be made possible by increasing the waste levy. Also, they knew that compliance with regulations at different levels, especially at that of the city council could be a barrier to everyone considering using RRBMs in their projects.

Figure 51. Common codes and differences between architects and regulators

Architects paid more attention to the detailed characteristics of materials when discussing the challenges of using RRBMs, while other aspects like health and safety were more important for regulators. Regulators were more concerned about politics, shortcuts in regulations, and supporting the use of RRBMs through better laws and regulations. Architects felt they could act at other levels, for example, by having a better communication with builders, clients, demolition, deconstruction and salvage companies, and having a database of materials with the required information. However, they felt there was a need to treat information and advertisements with caution. They also felt there was a gap between claims and performance in the construction industry, noting this as greenwash.

8.7.2 Architects and consumers

Common codes between architects and consumers were generally around the characteristics of materials and issues of communication between stakeholders in building construction. Because consumers do not have specific expertise in this area they only commented on typical challenges or issues based on their personal experiences. In Figure 52, blue shows the codes in common for both groups and purple the different ideas of consumers that were not seen in the architect group.

Similar to other stakeholders, cost was one of the most critical factors when using RRBMs. The consumers mentioned health and safety as an important factor although this did not come up in the architect group discussions. Consumers thought that RRBMs were limited to specific purposes but when different examples were presented in the group, they were interested in the idea of using them. In contrast, architects were familiar with the examples but had specific concerns regarding the technical aspects.

Consumers did not have much to say about the responsibilities and challenges of other stakeholders but did comment on manufacturers. Both architects and consumers agreed that manufacturers have the highest risk among stakeholders, but that they should provide transparency of information with labelling based on sufficient research and tests. Consumers thought it was the responsibility of environmentalists to educate people, but architects thought environmentalists should also criticise others when they have expertise. Other

common challenges for stakeholders discussed by both groups included better communication between stakeholders as this could solve many problems, not understanding the financial benefits, not being aware of environmental impacts and RRBMs, the lack of market demand, and the lack of bravery in starting to use RRBMs. Consumers felt the important first step was to change the mindset of people.

Other topics discussed in the architect group not brought up by consumers are discussed in sections 8.4.3. and 8.4.4. As discussed in section 8.6.3., consumers felt they did not have enough information regarding regulations and certification.

8.7.3 Regulators and consumers

In Figure 53, blue shows the codes in common between both groups and purple the different ideas of consumers that were not seen in the architect group. Durability, cost, and the health and safety of materials were important for both regulators and consumers. Obviously, regulators had more concerns compared to consumers regarding material characteristics and compliance with city council consent requirements, and the neglected responsibilities of stakeholders as discussed in sections 8.5.2. and 8.5.3. They had similar opinions about the role of architects in the design process and in changing the opinions of their clients and guiding them through the use of RRBMs.

Regulators thought that the consumer group complaints about the cost of consenting were not fair and that people always go for the easiest option. The regulators felt consumers did not have enough knowledge in this area, they followed fashion and were against changes in regulations. Both groups felt manufacturers carried the highest risk in a market of RRBMs, but that they should care about the transparency of their information. Consumers said it was the responsibility of manufacturers to invest in researching material characteristics. Both groups had many common ideas about the challenges faced by stakeholders noting the necessity of changing the mindset, the low market demand from the consumer side, and the need to be brave so as to be in the front line for change, the importance of the financial benefits of RRBMs as well as the costs of purchasing/reusing/repurposing and recycling materials and of their disposal, the increasing awareness in society of the need to save natural resources and

undertake environmental conservation, and the lack of communication between stakeholders.

Figure 52. Common codes and differences between architects and consumers

Figure 53. Common codes and differences between regulators and consumers

8.7.4 Architects, Regulators, and Consumers

Since architects and regulators are more knowledgeable about the building industry, most of the new ideas emerged from their group, but as can be seen in Figure 54, all three groups have a lot in common in figuring out the challenges to and opportunities for the use of RRBMs.

Earthquakes are an issue in New Zealand that need to be addressed in every building project, and this was a common theme for all groups. All groups talked about the need for materials which were lightweight, durable and structurally sound. Cost was the concern of everyone when choosing a product, whether or not it was recycled. All participants recognised that architects played a vital role in the design process and the possibility of integrating RRBMs into projects was partly dependant on the function and type of building, for example whether it is residential or commercial. They were aware of the lack of communication between different stakeholders. All participants knew that increasing awareness would be the starting point both in creating a market demand and in changing attitudes and behaviours. Hence changing the mind-set of people would be a turning point. All expected manufacturers to provide transparency of information, so those involved could make a conscious decision with the help of labelling information. These implied manufacturers needed to invest in research to test RRBMs in terms of their physical, thermal, mechanical and acoustical behaviour.

The very few codes that the consumer group added to the previous two groups were about their specific need to have more knowledge. This meant the environmental labelling of products, knowing how to deal with products at the end of their life and the related regulations, and having the required education on these issues from environmentalists.

8.8 Collation of results

This chapter set out to examine some of the questionnaire results by gathering a deeper understanding of them and finding the reasons behind them through focus group discussions and interviews.

Drawing thematic maps helped to figure out the common themes and differences in opinion that emerged from the results of the questionnaire for the three groups of architects, regulators and consumers. Findings from this qualitative analysis suggested a consistency with the results of the literature review regarding the important issues for increasing the use of RRBMs (see section 5.2).

Figure 54. Common codes and differences between architects, regulators, and consumers

Figure 55. Common themes and codes, and their relative frequency (the darker the green, the higher the frequency).

8.8.1 Bottom-up approach

The three main themes of materials, stakeholders, and regulations appeared in all groups after extracting the codes from the transcripts. Then an iterative process was begun to check the meaning of the codes and put them in the right sub-themes. By going back and forth all codes were classified to form a thematic map for all groups. This then showed the importance of issues which were repeated more and that everyone agreed on. Figure 55 shows the relative frequency of these common codes in the thematic map. The darker the green, the higher the frequency of the repetition. Financial benefit with the darkest green was repeated more than the other codes, and remained the most important challenge based on the opinion of participants. This was followed by awareness and the design process as the next most repeated codes. As mentioned before in sections 3.1.1 and 3.2.1, increasing awareness is the first step in change (Biswas & Roy, 2015; Y.-K. Lee et al., 2012). Additionally, the design process is the first step in a building project using RRBMs (Ekanayake & Ofori, 2004; Osmani et al., 2008), and architects have the most critical role in this step, recognising that integrating RRBMs will make this process more time-consuming.

All participants accepted that social and global pressure was changing the attitudes of people and market demand, and that manufacturers carried the highest risk so they should be supported by government. Lack of communication between stakeholders was also discussed in all groups as a big barrier to transferral of information and to making wise and conscious decisions. Compliance with regulations was also a challenging step that involved aspects like the characteristics of materials.

8.8.2 Top-down approach

Creating the thematic map was a bottom-up approach because it was shaped by adding codes one by one after analysing each group and each interview. The last step after completing the thematic map was to see the big picture and understand the essence of all these codes. This was a top-down approach that resulted in a model that matched the outcome of the literature review.

This model (Figure 56) shows that discussions were mainly focussed on the three areas of communication between groups of stakeholders, compliance with regulations and the cost of RRBMs. All of the repeated codes shown in Figure 55 can be classified into these three aspects.

The obstacles found in the literature review (section 2.1) consisted of three main issues. These were the attitudes of people that can be changed through education and communication, the necessary regulations and certificates for obtaining compliance, and the cost of integrating RRBMs in a building project.

Figure 56. A model to summarize the results of the qualitative analysis based on a top-down approach.

9 Linking quantitative and qualitative results

9.1 Introduction

This chapter discusses ways in which the results from the qualitative and quantitative phases informed one another. This integration, as part of the mixed-method approach, was used to explore and explain the results. In the sequential explanatory model adopted in this study, qualitative data was used to help explain quantitative findings. Where possible support for the findings was sourced through the literature. The aim was to reveal any contradictory findings between the quantitative and qualitative analyses, and the literature. This would mean the strength of findings could be enhanced through triangulation across the research phases and literature review. The divergence in results could reveal questions for future research. The qualitative findings might challenge quantitative results, but at least this might support the idea that for example such relationships could exist, and that these could warrant further investigation. Although individuals will each have a different view of reality, major patterns may only be seen through the big picture and through a quantitative approach using a large sample of the population.

This discussion below demonstrates that the mixing of methods in this study was a necessary, and ultimately productive aspect of the research. It led to outcomes that on one hand could be generalisable, and on the other could be supported by individual experiences and the literature. However, each phase of the study also produced findings that were unique like the examination of the TPB in the quantitative analysis.

The main topics discussed below from both the quantitative and qualitative phases were in the order in which they appeared in the questionnaire. Where possible demographic and occupational differences were discussed.

9.2 Environmental orientation

The environmental orientations of the respondents were measured using the NEP scale. As stated in section 6.2., overall the respondents had pro-ecological attitudes, while earlier studies from the literature had mean scores in the mid-ecological level (Thomson & Versus Research Ltd, 2008; Versus Research Ltd, 2016). Participants in the focus groups and interviews reflected this change,

stating *“New Zealanders are becoming much more environmentally aware”* and there is a *“a big shift in the general attitude.”*

Statistical analysis showed occupation had a significant effect on the NEP scale results (section 5.3.2). When focus group and interview participants were asked to comment on occupation and the NEP scores of survey respondents, opinions differed. Some said mind-set was based on occupation or occupation motivated people to be environmentally friendly, so regulators who worked with related policies and environmental issues, environmentalists, and architects who were interested in environmental issues might have higher NEP scores compared to manufacturers, builders, and consumers, as their occupations were not geared to considering the environment. These findings were also consistent with the literature in that education and occupation have a positive influence on environmental attitudes (Hawcroft & Milfont, 2010; Kurisu, 2015). The literature review also suggested other demographics, such as age were not always influential, as was the case in this study.

9.3 Environmental behaviour

The same trend was evident in environmental behaviour in that manufacturers, builders and consumers were less likely than environmentalists, regulators and architects to undertake reuse and recycling in both their personal lives and construction practices (see section 6.5). In general, environmentalists gained a higher score for reuse and recycling activities in their personal lives, while architects and regulators gained higher scores for these activities in their construction experiences. The respondents in the qualitative study felt the reasons for not engaging in environmental behaviour were that *“everything is determined by the price”*. They also felt that manufacturers take *“the highest risk”*, *“it is not convenient for builders to incorporate this”*, consumers *“...pick the easiest option around”*, and *“regulators make rules, ...they do not spend anything”*. The architects thought environmental behaviour was *“profitable according to the population and resources...but time consuming”*, and that environmentalists could *“inspire”* others.

Examining the TPB in the literature indicated that perceived behavioural control and attitude can mostly predict behaviour directly or indirectly through intention (Ajzen, 1991; Li et al., 2015). Discussions in the focus groups and interviews also showed that the challenging topics were almost the same as the perceived behavioural control items. These topics were cost, availability of information, accessibility and other factors that make it difficult or easy to perform the behaviour,

such as the cooperation of stakeholders. Additionally, groups of stakeholders who were known to have more positive environmental attitudes also had a higher level of environmental behaviour, specifically by doing more reuse and recycling. This supported the prediction of this behaviour by the NEP scores (Begum et al., 2009; Li et al., 2015; Ogunbode, 2013; Roberts & Bacon, 1997).

Reviewing the literature regarding the predictors of behaviour in TPB also showed that attitudes and perceived behavioural control could have a significant influence on environmental behaviour, especially when it came to implementing waste reduction strategies in construction projects (Begum et al., 2009; Li et al., 2015). This was consistent with the results of this study.

9.4 Green purchasing

In the light of the results of the online survey, although RRBMs were seen as an environmentally friendly alternative to conventional materials, price, availability, and other influential market factors still played their role in the purchasing behaviour of consumers. This held true for RRBMs as well as other green products. Price and self-satisfaction were the most influential factors in this study based on the percentage of people who agreed or strongly agreed with their influence on their purchasing behaviour (see section 6.7.1). This influence was also apparent in the qualitative study. The key factors influencing the purchase of green building materials were material specifications, the social and global pressures to save natural resources, the cultural context of society in terms of fashion and the obsession with newness, the influence of some stakeholders on others like architects, the required infrastructure for locating suitable RRBMs, the availability of materials in their area, transparency of information and labelling of materials, the role of advertising and the necessity of filling the gap between performance and the claims of manufacturers and suppliers. However, it was felt these factors might change for specific materials. For example, using recycled materials in an indoor environment or as outdoor furniture is much less of a problem as the finished product is more guided by appearance than performance and structural stability.

The literature also supported the idea that attitudes toward green purchasing were influenced by the transparency of information, doubt and dissatisfaction about products and manufacturers, price and benefits, performance and quality, knowing how consumers communicate with media, social pressure, and convenience (Bendell & Kleanthous, 2008; Biswas & Roy, 2015; Tim Denne et al., 2007; Dursun et al., 2016; Khare, 2015; Lemke & Luzio, 2014).

Material attributes like aesthetics, recyclability, durability, weight, texture, acoustic performance, thermal performance, weather tightness, fire resistance, structural stability, insect resistance, health and safety, and environmental impacts were among the important characteristics for participants in the qualitative study. The online survey results showed that performance and durability came first, then health and environmental impacts, with cost and safety the last factors. In contrast, participants of the focus groups and interviews said cost was the first priority for everyone, then performance and then the other factors. It is not clear why this difference emerged, although it might be partly due to the fact that people try to present themselves as being more environmentally friendly and less concerned about money when they answered the survey questionnaire, while those who participated in the focus groups really wanted to have a role in changing the situation and having a building industry with fewer environmental impacts. This meant they were more willing to face the problems and discuss these in the focus groups and interviews, which is one of the purposes of having the qualitative study.

9.5 Pillars of sustainability

The social, economic and environmental aspects of using RRBMs were evaluated by the respondents in the online survey. This showed that the environmental aspect was more important for them than the economic, followed by the social. In contrast, the focus groups and interview results indicated that cost and financial benefits were more important than the other factors, and the literature review showed that price and economic incentives play a critical role in both green and non-green purchase behaviour (Dursun et al., 2016; Grant, 2011; Pedro Pereira Luzio & Lemke, 2013). As stated in section 8.4, price and self-satisfaction were the more important factors above social or environmental factors. Analysis of the characteristics of materials in the online survey also supported the idea that factors like performance or environmental impact can be more important than cost. These contradictory results gave evidence of the gap between attitude and behaviour that was also discussed in the literature review (see section 3.1.2) (Kurusu, 2015).

9.6 Regulations and certification

Based on the results of the online questionnaire, most respondents did not appear to have enough information regarding regulations and certification related to RRBMs, with architects having the

most and consumers the least knowledge respectively. Architects, manufacturers, builders and regulators all declared they had some knowledge of the few existing relevant regulations and certificates. The consumer focus group had no idea there were any regulations or certificates relating to the use of RRBMs and had only heard about the waste levy.

The architects in the focus group knew that certain green building certificates included the use of these materials, but that this did not score many points and could be ignored. They said that material certifications did not always provide enough information and could not be totally trusted. The architects knew about the waste levy but did not feel this was an incentive to reduce waste or reuse and recycle since the doing the latter is more time consuming and time is money in building construction projects. However, they knew that generally the advantages from reuse and recycling might outweigh disadvantages depending on the project type.

The regulators were hopeful there would be more regulations to support the use of RRBMs in building projects. They were aware of product stewardship schemes and that these were growing and could in the future include building materials. In terms of legislation, they felt the Waste Management Act was at the top followed by the Regional Waste Minimization Strategy, and then the strategy of each council. They felt this gave a base but there needed to be more detailed strategies to support the use of RRBMs and ease the consent compliance process for these materials. They also felt the manufacturers of recycled materials or those who wanted to remanufacture products needed the support of regulations and economic incentives from the government.

9.7 Roles and responsibilities

Results of the quantitative study showed that regulators and architects were the two key stakeholder groups that could influence change regarding the use of RRBMs, with end-users in third place. A barrier to change that was identified in both the literature review and qualitative discussions is the personal mind-set, which tended to push the responsibility for doing something that was perceived to be a good thing onto other stakeholders, especially where there was no regulation to enforce the action.

Results of the survey showed that environmentalists, regulators and consumers thought manufacturers had the more important role in enhancing the use of RRBMs, while manufacturers,

architects and builders felt consumers had the more important role. All groups except environmentalists accepted that changing public attitude through increasing knowledge is the responsibility of regulators, while environmentalists thought this was part of the role of architects. Architects and builders were aware of their role in using RRBMs in projects and the consumer group expected them to do this. All of the focus groups expect the regulators felt there was a need to provide assurance regarding the health and safety of RRBMs, which could be done through a comprehensive materials certification scheme. All focus groups agreed the architect should take account of the ideas of end-users when a project involves designing for a group. There was also the feeling that it was the responsibility of architects to inform clients about the advantages and disadvantages of RRBMs. However, the group of architects said that they needed the knowledge of engineers and experience of builders when there is no system of labelling for RRBMs.

9.8 Conclusion

This study suggested that New Zealanders in the building construction sector were becoming more environmentally friendly in terms of the scoring of their pro-ecological attitudes, while their behaviour could be predicted by their attitude. Another finding was that both attitude and behaviour were influenced by other factors like occupation. The influential factors on attitudes and behaviours were also different for each stakeholder group. Among demographics, education also had a significant influence on attitudes and behaviour.

Environmentalists, regulators and architects scored higher in the survey in terms of environmental attitudes and behaviour compared to manufacturers, builders and consumers. The behavioural models of the stakeholder groups were different, but generally could be predicted by perceived behavioural control and attitude.

Price and self-satisfaction were the most influential factors on green purchase behaviour, including buying RRBMs. However, there were some differences in the qualitative and quantitative results when it came to choosing a building material, although performance was a prioritised characteristic in both studies. There were also differences in the evaluation of the importance of using RRBMs in terms of the three pillars of sustainability. In the qualitative study respondents gave more importance to cost and financial benefits, which differed from the survey findings. This might show a direction for future market analysis.

Measuring the knowledge and awareness of respondents regarding regulations and certificates showed there is a long way to go to reach the position of the enforcement of relevant regulations and certification for every construction project. However, regulators and architects were viewed as the most important stakeholders to start the process of moving towards using more RRBMs in New Zealand.

The lens of being an architect was expected to play a critical role in the conduct of this research and a researcher in another field of study might do the qualitative study differently. However, including the opinions of different stakeholders can show the value of their various perspectives, and the possible influence they might have in creating a deeper understanding of the situation.

Little to no research had been done to show patterns of stakeholder involvement in the use of RRBMs in New Zealand, and this study has presented an evidence based overview of the current situation that might help all stakeholders in the construction industry approach the use of more RRBMs whatever their role or occupation.

9.9 Main findings and recommendations for the relevant actors

Mixing quantitative and qualitative methods produced a more profound and broader perspective of the current attitudes towards RRBMs based on the large sample size and their experiences. This in turn has made it possible to suggest recommendations for furthering the uptake of RRBMs. Some recommendations are consistent with the findings of other studies, and this might make them more reliable and generalisable while others are based on the results of this study and may only be applicable for the three cities studied. All relevant stakeholders, whether or not they have been in this study might benefit from the following recommendations that could lead to an increase in the use of RRBMs.

9.9.1 Education

Following an examination through the lens of the Theory of Planned Behaviour, it would seem that policymakers could enhance perceived behavioural control by increasing designers' awareness of waste management through legislation and educational programs. Studies have shown that a key barrier in the construction industry when it comes to environmental practices is the lack of training

and expertise. Hence, educating industry professionals on the environmental impacts of construction and material production processes taking a whole life cycle approach would reveal the problems of current construction methods (see sections 2.2., 3.2.1 and 6.3.4). Educating architectural students for design for disassembly could lead to enhanced use of RRBMs in the future (see sections 2.4.1.1. and 2.4.2.). Educating contractors and encouraging them to use RRBMs is probably a role for government. However, once educated in this way those managing projects can then teach subcontractors (see sections 2.2., 3.2.1 and 6.3.4). Manufacturers also need to invest in research of how to test RRBMs in terms of their physical, thermal, mechanical and acoustical behaviour. This suggests funding research projects on the technical issues of RRBMs whether by government or manufacturers is essential (see sections 2.2.1., 2.4.4., 6.10. and 8.3.1).

9.9.2 Regulations, certification, and rating systems

Further studies need to focus on policies and regulations related to the use of RRBMs. It would also be useful to look at other stakeholders involved in the construction industry, such as engineers, so that appropriate policies and regulations can be produced. Based on this study alone, recommendations can be made in terms of policy and certification to facilitate both the purchase of RRBMs and more reuse and recycling activities in the building construction process. The architects in the focus group knew that certain green building certificates included the use of these materials, but that this did not score many points and could be ignored. They said that material certifications did not always provide enough information and could not be completely trusted. They also identified a hierarchy of acts and regulations they believed were needed for innovation to really thrive. The regulators were hopeful there would be more regulations to support the use of RRBMs in building projects. They were aware of product stewardship schemes and that these were growing and could in the future include building materials. In terms of legislation, they felt this gave a base but there needed to be more detailed strategies to support the use of RRBMs and ease the consent compliance process for these materials. New regulations needed to be based research and also updated regularly. Updating information regarding waste composition and volume in the building construction industry and studying the feasibility of suggested solutions would be key starting areas (see sections 2.1., 2.2.1. and 2.5.). They also felt the dealers in recycled materials or those who wanted to remanufacture products needed the support of regulations and economic incentives from the government. Current regulations are not inclusive of all types of projects. For example,

they may only ask big projects to abide by the regulation to reduce C&D waste although the number of small projects which could have a role in reducing waste is large enough to be included in the regulation. Current regulations exclude the residential sector that has great potential to reuse building materials and components (see sections 2.2. and 8.7.4.). Building rating systems could include the use of RRBMs and waste management planning to gain significant points (see sections 2.3. and 2.5.). Making regulation compulsory for all municipalities would be successful (see section 8.5.3.).

9.9.3 Specifications

Comparing the mean ranks of the stakeholder evaluations showed that “performance” was ranked highest, following by “durability, health, environmental impact, cost and safety”. Participants talked about the need for material labelling. Common codes between architects and consumers were generally around the characteristics of materials and issues of communication between stakeholders in building construction. All groups talked about the need for materials which were lightweight, durable and structurally sound. However, the architects group said they would need the knowledge of engineers and experience of builders unless there was a system of labelling for RRBMs. This is why agreed specifications for reused materials and components would make the consent process easier and create opportunities for improving the RRBM market (see sections 2.5., 8.6.1., 8.7.2., 8.7.4. and 9.7.). Another way could be through developing quality assurance techniques specifically for pre-used materials (see sections 2.4.4., 2.5., 3.1.1. and 9.4.).

9.9.4 Targeting stakeholders

Sometimes the target of the regulation is not the right stakeholder. For example, regulations may force the owner to reduce C&D waste in a project by a specific percentage, but are not directed at the architect or builder who is controlling the construction activity (see section 6.11.). The stakeholders felt the most important role for changing attitudes to encourage C&D waste reduction was the “regulator”. For implementing the use of RRBMs, the most important role was the “architect”. For checking the safety and performance of these materials, the most important role was the “regulator”. For making sure consumers are aware of RRBMs, the most important role was the “architect”. Other suggestions were made for finding the right target group of stakeholders. As

the world is paying attention to sustainability architects should find the design solutions that include, creative ways of using RRBMs, and inform other stakeholders of why decision have been made. Submitting the consent application to the city council, and knowing about relevant regulations is part of the architect's responsibilities. However, architects cannot check everything, and need to refer to the specifications given by manufacturers. Architectural creativity could play an important role here but architects need to influence suppliers. Currently the whole industry tends to be dominated by the suppliers. Architects are the primary advisor of consumers, and once they team up with regulators use of could be better promoted . Manufacturers should have all their products tested by BRANZ and information dispersed through material safety data sheets, and the REBRI was extremely well-positioned to do checking of RRBMs. Councils could have "material scientists" to do "tests on-site" when required.

9.9.5 Information, communication

Findings showed that lack of "*knowledge*", "*information*" or a "*database*" were reasons behind the underuse of RRBMs. Some of the main concerns of participants were the challenges regarding the use of RRBMs such as being a "*time consuming*" process, both in finding them on "*construction sites*" or doing "*research*" into them. Lack of communication between members of the construction industry was a very common reason for their underuse. For example, research is happening, but we do not have a right communication to disseminate the results, we do research, but the results are not disseminated well. The problem is not always lack of information, since there is "too much information out there", but rather there is a "definite networking gap" between stakeholders, so they cannot see the required information. Councils of big cities could collaborate with smaller cities to create a market for reclaimed materials and components, or facilitate their direct purchase from C&D sites, by providing a tool for finding appropriate reclaimed materials (see sections 1.2., 2.2.1., 8.3.2. and 8.7.3.). One example could be a "coordinated" buying and selling network for RRBMs in New Zealand. Cost was acritical factor and was the concern of everyone when choosing a product, whether or not it was recycled. Time is money in building construction projects. Communication via a good network between stakeholders could solve many problems, and result in understanding the financial benefits, environmental impacts, and market demand more easily and in a timelier manner. From another point of view, an integrated design process means involving all stakeholders from the very beginning so they can understand the goal of the project, and thus increase the

awareness of all people involved (see sections 2.2., 3.1.3., 3.2.1., 9.7. and 6.3.4). Sharing lessons learned from case studies or projects using RRBMs could help spread knowledge about them (see sections 2.2. and 8.5.2.). The various policies, guidelines and studies of government and other institutions have resulted in scattered information which is difficult for all stakeholders comprehend. Such information needs to be gathered into a comprehensive and inclusive document that is accessible for all, whatever their background and expertise. This is in line with the previous goals of REBRI (see sections 2.2.1. and 3.1.1.). There is a need to create internet-based exchange platforms in order to boost the market by giving information and gaining the support of related organisations. On these online platforms people could share what they have and what they want, so they can sell and buy the materials from demolition projects. This would cut out ‘the middle man’ and could lead to finding materials closer to the project site and maybe at a lower price (see sections 2.2.1. 8.3.2., 8.5.2. and 8.7.3.). All these solutions on top of having a platform for a better communication could help stakeholders to access the required information and reduce costs and time.

9.9.6 Deconstruction

Deconstruction of specific types of structure and construction techniques should be studied as part of understanding how to create RRBMs. This research could be supported by government (see sections 2.2., 2.4.2., 8.5.3., 8.5.2. and 9.6.). Also, architects and builders could learn from previous projects for estimating the cost of demolition with reclamation in mind. Having regulations for deconstruction as a step before reuse and recycling could solve the problem of lack of infrastructure for RRBMS, because this approach would provide a system for saving materials and components (see sections 2.2., 2.4.2., 8.5.3., 8.5.2. and 9.6.). Deconstruction is more time consuming and needs more expertise and effort, so it requires more people to be involved and this in turn creates more job opportunities, which is also aligned with government goals (see sections 2.2., 2.4.2., 8.5.3. and 8.5.2.). If producers have to take responsibility for the end of life of materials, they would be more conscious of their products and take responsibility for what happens at the end of their life. However, this could only be a practical solution for components or equipment with short life spans, because the life span of most building materials is long enough that the producer goes out of business. This would also be transitioning from a product-based model to a service-based model market (see sections 2.1.1. and 3.1.1.).

10 Conclusion

10.1 Answering the research questions

This study investigated the perceptions of stakeholders in the building construction industry regarding the use of RRBMs as a sustainable solution that would use fewer natural resources and generate less waste than currently. The aim was to find the challenges to and opportunities for using RRBMs. The roles, expectations, interrelationships, and demands across all stakeholder groups were identified, as were those stakeholders who could have the most influence in moving the construction industry toward this goal. An explanatory sequential, mixed-method approach has been used to collect quantitative data and explore them deeper within a qualitative study in order to answer the research questions. The involvement of a multitude of stakeholders was helpful in creating a multidimensional conceptualisation of how it might be possible to reach sustainable goals in the construction industry. The aim has been to understand the situation in terms of attitudes and behaviours so as to show the results to decision-makers and other relevant audiences in New Zealand.

The primary research question to be answered by this study was:

- What are the perceptions of different stakeholders around the use of RRBMs?

This question was answered partly through the analysis of the environmental attitudes of respondents, as these are the basis behind undertaking any environmental behaviour, such as the use of RRBMs. Stakeholders in the construction industry were first identified as architects, builders, manufacturers, regulators, environmentalists and consumers. As groups, these stakeholders had different levels of environmental attitudes, although overall the mean score for all participants showed they were pro-ecological. Education level, occupation and ownership of property also influenced environmental attitudes. Apart from the stakeholders directly associated with environmental activism, the architect group were more environmentally friendly than other construction industry groups. Analysing the behaviour of stakeholders in terms of socio-demographic data and their occupations indicated that women and people with tertiary education were more likely to reuse and recycle. Occupation also had an influence on this behaviour.

Architects and builders claimed that they promoted the use of RRBMs by using them in their projects. However, respondents other than architects and builders, had not undertaken activities towards promoting RRBMs, even perhaps surprisingly the environmentalists. Consumers had the least and architects the most knowledge of regulations and certification in this area.

The primary research question was further explored to complete the answer by analysing the perceptions of respondents regarding the influential factors on their purchase characteristics. This revealed price and self-satisfaction were the most influential factors on green purchasing, and age, gender, and income could predict these factors. All stakeholder groups thought that the environmental aspect is the most important when it comes to the use of RRBMs, followed by the economic and social aspects. When choosing RRBMs, performance and durability were the most important material characteristics for the whole sample, although the different stakeholder groups held these in different priority order. Other factors were environmental impacts, cost, health and safety. The results of the qualitative study were different in this area, as here everyone gave priority to the cost and financial benefits.

Two further questions were written to support and guide the research effort. The first of these sub-questions was:

- How can attitudes of stakeholders be influential on the use of RRBMs?

In order to answer this question, it was necessary to investigate the behavioural models of the stakeholder groups. Examining the TPB showed that architects with higher scores for environmental attitudes (NEP) had stronger intentions (Int) to do more recycling or buy more recycled materials (Beh). However, their intentions (Int) were also influenced by factors affecting green purchase behaviour (PBC1), and knowledge of related regulations and certificates (PBC2) could also influence their behaviour. The behavioural models of other stakeholders were somewhat different, but for all environmental attitudes and perceived behavioural control were strong predictors (see section 6.4, 6.5).

The second sub-question was:

- How may a diversity of perceptions shape the role of architects?

As the building construction industry involves a diversity of stakeholders, their roles in promoting the use of RRBMs may be different. Different studies have investigated the role of designers and architects in planning the waste management of construction projects since the design stage is one of the most important when it comes to reducing C&D waste. Considering using RRBMs as one of the waste minimisation strategies, architects were felt to be a key stakeholder here, and their role was discussed in the focus groups more than the roles of others. Architects and regulators were perceived as the two most important stakeholder groups when it comes to leading and influencing the use of more RRBMs in projects. Providing the required regulations and certifications exist architects have the most important role in this process in order to reduce waste. Although most stakeholders were aware that they could have a role and play even a small part in this, they usually tried to push the responsibilities to others, especially given the lack of regulations to enforce such use or the lack of sufficient information both about the materials or the related regulations and certifications. This suggests that it is better to assign responsibilities so as to make less confusion in what should happen in projects. One of the other factors was the mindset of consumers who are the clients of architects, and this can be partly solved through architects informing them about and encouraging them to use RRBMs. However, architects need to be trained during their studies or in their professional career to apply waste minimisation strategies. Architects also have the opportunity of designing out waste from the process by designing for disassembly, and also by using RRBMs in projects, so as to reduce waste at source. This approach needs good communication between the design team, specialist such as engineers, and builders. Making this communication work could be part of the role of architects who lead the team.

In this situation, architects could have a leading role and be decision-makers in the process of choosing RRBMs. They could do this by;

- encouraging clients to use RRBMs by informing them about the difference between the environmental impacts of new products made from raw materials and RRBMs and highlighting the benefits of using the latter, as well as showing clients previous examples and case studies;

- specifying appropriate materials and performance levels, doing the required research about the materials, finding the right options, providing the opportunity and the right place to use them, planning how to use them, cost evaluations, integrating them into the project in line with clients' needs and requirements, detailing and preparing alternative designs;
- asking for supporting documents and certifications for such materials from manufacturers, or certifying organisations;
- providing more possibilities for reusing by designing for deconstruction.

As discussed, larger construction companies who have more building projects have more opportunities to use and learn from their own project experiences, and to use materials left from one project in their other projects. This may depend on the type of building, however, all types have their own specific opportunities for using RRBMs, whether they are residential or commercial, or big or small. For example, small residential buildings which usually have a timber structure have a really good opportunity to reuse old timbers that get harder with age, or big concrete commercial buildings can use recycled aggregates for the concrete.

10.2 Contribution to knowledge

As shown in section 3.4, there is a lack of literature on stakeholders' attitudes and mind-sets in the construction sector when it comes the use of RRBMs as a strategy towards developing a more sustainable construction industry. One of the major contributions of this research has been adding to the literature in this area by measuring stakeholders' environmental orientations and the factors influencing their uptake of RRBMs. This study also tried to discover the driving force behind increasing the use of RRBMs, and respond to this gap in knowledge by investigating this issue based on the opinions of construction industry stakeholders.

The part of this study that used the NEP scale showed an increase in the level of environmental attitudes of people compared to previous studies in New Zealand. However, at this point it is not clear whether this reflects a general increase in environmental awareness in New Zealanders, or whether some construction industry stakeholders are more aware than the general population.

Another finding came from using the TPB to examine the behavioural models of stakeholders in the construction industry. Examining the TPB proved that attitude, perceived behavioural control and

intention are good predictors of engaging with reuse and recycling, while subjective norm can be removed from the model for this group of people.

Overall, this research created new knowledge by extending the literature in terms of the perceptions of construction industry stakeholders and influential factors on their use of RRBMs. The main finding of this study was that to increase the use of RRBMs, the different stakeholders need to be communicated with in different ways, and according to the factors that most influenced their behaviour regarding RRBMs. For achieving the best result, it is essential to know how each type of person in the construction system behaves, and this is the main finding of this thesis. The research also offers further support for use of the NEP scale and the TPB as a means of understanding the motives behind the behaviour of those in the construction sector in New Zealand when it comes to using RRBMs. This in turn made it possible to give recommendations to increase their uptake as a means to having a construction industry with fewer environmental impacts.

10.3 Further research areas

This research has given a list of recommendations in section 9.9 based on the findings of this study, and future studies could explore these recommendations further to check whether they are fully practical. One of the recommendations is to create an online platform to link people who want to sell and buy RRBMs and to give required information about these materials and components. A future study could design this platform with the help of learning from examples of other countries, which could be part of the REBRI goals, and test it to check its practicality.

As found in this study, a lack of required regulations and certifications and the lack of knowledge about those that already exist are part of the challenge to waste reduction through using RRBMs. There is a need to study what already exists to see how they can be more effective, and how to increase the awareness of people about them.

It would also be useful to research specific recycled components and building materials further, as well as materials with recycled content, to discover the differences in perceptions of people of these, and especially between structural and non-structural RRBMs.

Another future study could be linked to the training of architects and students could learn how to design for deconstruction and how to reduce C&D waste.

The TPB was examined in this study as part of the analysis, but there are other measurable influential factors like self-satisfaction that could be examined in combination with this theory as an extended model of behaviour. Also, the subjective norm did not emerge as a significant predictor in this research and this area may need more accurate measurement in future studies.

10.4 Limitations

One of the limitations of this study is the inclusion of selected stakeholders in the building construction industry, although those chosen were felt to be more related to the use of RRBMs. However, other stakeholders like structural and mechanical engineers who advise architects and builders may have a role in their decision making.

Measuring the behaviour and knowing how much architects and builders care and use RRBMs in their projects is an act that can be measured by observation and experiment. This would give more accurate results than were possible with the survey methods used in this study.

It was challenging to find the same number of people for each focus, so some results could be skewed in the statistical analysis. There was also difficulty in finding interested regulators to participate in focus groups, and arranging them in one place, and at the same time, so separate interviews were planned for them and this could again have produced different results from those that emerged in the true focus group discussions.

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Appendix 1

This presentation was used to show some examples of materials as part of question 4 of the focus groups and interviews.

Reclaimed and recycled material examples

Available or potential to be produced in New Zealand

Classification of materials:

Refrigerator doors
into a food truck

Discarded rotor blades
into a playground

Glass bottles
into a wall

Reclaimed materials

Wonderwall: A collage using a variety of
old pieces of wood arranged in various
depths.

eco shingles

EcoStar is manufactured with an 80% recycled compound that includes rubber and polymers, from the likes of recycled car bumpers, radiator hoses and door mouldings.

eco-terr panels

Made of recycled natural stone aggregates and glass, for floors, surfaces, or wall panelling.

By Fusion

Non-loading bearing concrete blocks and exponentially superior thermal/sound insulation. Requires no glue or adhesives to use 95% lower greenhouse gas emissions than concrete blocks, and won't crumble under pressure.

Bio-luminum

Bio-Luminum tiles are made of 100% recycled aircraft aluminium suitable for high-traffic flooring as well as high-end wall treatments.

Rice husks

A new weather-resistant and waterproof material made of 60% **rice husks**, together with 22% rock salt and 18% mineral oil. . It has initially been used for outdoor furniture, floor coverings, and ships' decks.

OSSB panel

Novofibre boards Consist of 100% wheat straw and are available for various applications (including base sheets, sound-absorbing surfaces, flooring, plywood, and a range of decorative panels)

Main results of the online survey questionnaire

Some key issues to discuss

Full explanation of these slides was giving to participants in the discussion sessions.

Frequency of occupations:

666 respondents

New Environmental Paradigm scale:

543 respondents

Material specifications-key issues:

596 respondents

Boxes on the right show the mean scores of each group

Knowledge about regulations and certificates:

579 respondents

Behaviour

• Practices relevant to buildings and materials

• Practices relevant to general reuse and recycling

These graphs show the average frequency of recycling behaviour in general (left) and for RRBMS (right) for each group of stakeholders. Green circles show the groups who are performing these behaviours more, red circles show those who are performing them less than others and yellow circles show the mid-range.

Enhancing reuse and recycling of building materials

Manufacturer	22.2%	16.2%	20.4%	31.0%	30.2%	26.9%	22.5%
Builder	8.9%	7.0%	1.5%	11.9%	7.0%	15.1%	8.0%
Architect	15.6%	18.3%	13.9%	14.3%	14.0%	10.1%	14.5%
Environmental	0.0%	0.7%	0.7%	4.8%	0.0%	2.5%	1.2%
Regulator	26.7%	21.8%	24.1%	16.7%	25.6%	19.3%	22.5%
Consumer	26.7%	35.9%	39.4%	21.4%	23.3%	26.1%	31.2%
	Manufacturer	Builder	Architect	Environmental	Regulator	Consumer	Total

5.1

Changing attitudes to reuse and recycling of building materials

Manufacturer	12.2%	11.3%	10.9%	7.1%	14.0%	15.1%	12.0%
Builder	8.9%	4.2%	5.8%	11.9%	11.6%	5.0%	6.6%
Architect	18.9%	18.3%	17.5%	28.6%	18.6%	16.8%	18.7%
Environmental	7.8%	5.6%	14.6%	16.7%	9.3%	10.9%	10.3%
Regulator	27.8%	33.1%	29.2%	26.2%	23.3%	26.1%	28.6%
Consumer	24.4%	27.5%	21.9%	9.5%	23.3%	26.1%	23.7%
	Manufacturer	Builder	Architect	Environmental	Regulator	Consumer	Total

5.2

Implementing the use of these materials

Manufacturer	<div><div></div></div> 11.1%	<div><div></div></div> 8.5%	<div><div></div></div> 8.8%	<div><div></div></div> 26.2%	<div><div></div></div> 14.0%	<div><div></div></div> 10.1%	<div><div></div></div> 11.0%
Builder	<div><div></div></div> 16.7%	<div><div></div></div> 9.9%	<div><div></div></div> 5.8%	<div><div></div></div> 11.9%	<div><div></div></div> 25.6%	<div><div></div></div> 16.0%	<div><div></div></div> 12.6%
Architect	<div><div></div></div> 24.4%	<div><div></div></div> 35.9%	<div><div></div></div> 40.9%	<div><div></div></div> 23.8%	<div><div></div></div> 14.0%	<div><div></div></div> 28.6%	<div><div></div></div> 31.2%
Environmentalist	<div><div></div></div> 0.0%	<div><div></div></div> 1.4%	<div><div></div></div> 1.5%	<div><div></div></div> 0.0%	<div><div></div></div> 2.3%	<div><div></div></div> 1.7%	<div><div></div></div> 1.2%
Regulator	<div><div></div></div> 35.6%	<div><div></div></div> 28.2%	<div><div></div></div> 26.3%	<div><div></div></div> 26.2%	<div><div></div></div> 25.6%	<div><div></div></div> 27.7%	<div><div></div></div> 28.4%
Consumer	<div><div></div></div> 12.2%	<div><div></div></div> 16.2%	<div><div></div></div> 16.8%	<div><div></div></div> 11.9%	<div><div></div></div> 18.6%	<div><div></div></div> 16.0%	<div><div></div></div> 15.5%
	Manufacturer	Builder	Architect	Environmentalist	Regulator	Consumer	Total

5.3

Checking safety and performance

Manufacturer	<div><div></div></div>	23.3%	<div><div></div></div>	17.6%	<div><div></div></div>	20.4%	<div><div></div></div>	19.0%		7.0%		9.2%	<div><div></div></div>	16.8%
Builder		8.9%		14.1%		10.9%		9.5%		4.7%		10.9%		10.8%
Architect		2.2%		10.6%		8.0%		0.0%		7.0%		7.6%		7.0%
Environmentalist		1.1%		0.7%		0.7%		0.0%		2.3%		2.5%		1.2%
Regulator	<div><div></div></div>	64.4%	<div><div></div></div>	54.2%	<div><div></div></div>	59.1%	<div><div></div></div>	66.7%	<div><div></div></div>	72.1%	<div><div></div></div>	68.1%	<div><div></div></div>	62.1%
Consumer		0.0%		2.8%		0.7%		4.8%		7.0%		1.7%		2.1%
	Manufacturer	Builder	Architect	Environmentalist	Regulator	Consumer	Total							

5.4

Integrating ideas of using RRBMs in the project

Manufacturer	21.1%	11.3%	17.5%	7.1%	9.3%	9.2%	13.4%
Builder	6.7%	10.6%	2.2%	14.3%	18.6%	12.6%	9.2%
Architect	42.2%	57.7%	52.6%	52.4%	53.5%	49.6%	51.7%
Environmentalist	6.7%	4.9%	3.6%	7.1%	0.0%	5.9%	4.9%
Regulator	15.6%	8.5%	15.3%	16.7%	14.0%	10.9%	12.7%
Consumer	7.8%	7.0%	8.8%	2.4%	4.7%	11.8%	8.0%
	Manufacturer	Builder	Architect	Environmentalist	Regulator	Consumer	Total

5.5

570 respondents

This graph shows the average scores of the whole sample for the different questions regarding the roles and responsibilities related to use of RRBMs.

Roles:

others' roles

- no
- manufacturers (yes)

knowledge of related regulations

- no

effective occupation

- yes
- regulators and consumers (no)

agree

- yes

suggest

- yes

6

Appendix 3

Poster attached to the invitation email for the online survey

Invitation for participants

"The greatest threat to our planet is the belief that someone else will save it."

Robert Swan

Appendix 4

Online questionnaire

Intro

Stakeholders' roles in enhancing the reuse and recycling of building materials in New Zealand

INFORMATION FOR PARTICIPANTS

You are invited to take part in this research. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to participate, thank you for considering this request.

Who am I? My name is Zahra Balador and I am a Doctoral student in Architecture at Victoria University of Wellington. This research project is work towards my thesis.

What is the aim of the project? This project investigates the role of architects, as decision-makers, in selecting recycled building materials in the process of building construction, compared to the role of other stakeholders in the market for recycled building materials. The ambiguity in perceptions of stakeholders and the perceived most influential stakeholder in increasing the use of recycled building materials will be addressed. The main contribution of this study is expected to find various stakeholders' perceptions about each other that form their responsibilities. That may potentially lead to an understanding of gaps and opportunities towards increasing the use of reclaimed and recycled building materials. Finally, this study also has the potential to provide indications to stakeholders on how to assess their situation themselves.

This research has been approved by the Victoria University of Wellington Human Ethics Committee 24662.

How can you help? You have been invited to participate because as a stakeholder, who has some influence on this market, you are uniquely qualified to speak to the research query examined in this investigation. If you agree to take part you will complete a survey. The survey will ask you questions about your attitudes and perceptions about reclaimed and recycled building materials. The survey will take you 20 minutes to complete.

What will happen to the information you give? This research is anonymous. This means that nobody, including the researcher will be aware of your identity. By answering it, you are giving consent for us to use your responses in this research. Your answers will

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remain completely anonymous and unidentifiable. Once you submit the survey, it will be impossible to retract your answer. Please do not include any personal identifiable information in your responses.

Personal details will be collected only for those who wish to enter the prize draw, request a copy of the final report, or participate in the focus groups. All personal details will be received separately from the survey data. This ensures that your answers to the survey questions are anonymous.

What will the project produce?

The information from my research will be used in PhD dissertation and academic publications and conferences.

If you have any questions or problems, who can you contact? If you have any questions, either now or in the future, please feel free to contact me or the thesis supervisors:

Student:

Name: Zahra Balador

University email address: Zahra.balador@vuw.ac.nz

Supervisors:

Name: Nigel Isaacs

Role: second supervisor School: Victoria University of Wellington Phone: 04 4639745 Nigel.Isaacs@vuw.ac.nz

Name: Morten Gjerde

Role: first supervisor School: Victoria University of Wellington Phone: 04 4636233 Morten.Gjerde@vuw.ac.nz

Human Ethics Committee information If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Associate Professor Susan Corbett. Email susan.corbett@vuw.ac.nz or telephone +64-4-463 5480.

End of Block: Introduction

Start of Block: Demographics

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Q1 What gender do you identify with?

- ☐ Male
 - ☐ Female
 - ☐ Other
-

Q2 Which of the following age brackets do you fall under?

- ☐ 18-29 years old
 - ☐ 30-49 years old
 - ☐ 50-64 years old
 - ☐ 65 years and over
-

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Q3 What is the highest level of education you have completed?

- ☐ Secondary school (college)
 - ☐ Trade/technical/vocational training
 - ☐ Bachelor's degree
 - ☐ Post graduate degree
 - ☐ None of the above
-

Q4 Which income bracket best describes your annual income? (before tax deductions)

- ☐ Less than \$19,999
 - ☐ \$20,000 to \$39,999
 - ☐ \$40,000 to \$79,999
 - ☐ \$80,000 to \$109,999
 - ☐ \$110,000 or more
-

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Q5 Including yourself, how many people live within your household?

- ☐ 1
- ☐ 2 - 3
- ☐ 4 - 5
- ☐ 5 or more
-

Q6 In which city do you live?

Q7 Are you a home owner? (Please tick one).

- ☐ Yes
- ☐ No
-

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Q8 Is your occupation related to reclaimed or recycled building materials?
(Please tick one).

- ☐ Yes
- ☐ No
-

Q9 What is your occupation? (Please tick one).

- ☐ In a building material manufacturing or salvage/ resale industry
- ☐ Builder, or working for a builder
- ☐ Architect, designer, or working in an architectural firm
- ☐ Environmental activist or in an environmental NGO
- ☐ In government or institutes, related to building or environmental regulations
- ☐ None of the above, please specify _____

End of Block: Demographics

Start of Block: General environmental attitudes

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Q10 Please select the option that best describes your opinion for each statement.- Please read each statement carefully. (Please tick one for each statement)

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
The balance of nature is very delicate and easily upset by human activities	☐	☐	☐	☐	☐
The earth is like a spaceship with only limited room and resources	☐	☐	☐	☐	☐
Plants and animals do not exist primarily to be used by humans	☐	☐	☐	☐	☐
Modifying the environment for human use seldom causes serious problems	☐	☐	☐	☐	☐
There are no limits to growth for nations	☐	☐	☐	☐	☐
Mankind is created to rule over the rest of nature	☐	☐	☐	☐	☐

End of Block: General environmental attitudes

Start of Block: Environment friendly building construction attitudes

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Q16 Please select the option that best describes your opinion about environment-friendly building construction for each statement. (Please tick one for each statement)

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Purchase or build sustainable buildings	☐	☐	☐	☐	☐
Purchase or build buildings with less carbon footprint	☐	☐	☐	☐	☐
Purchase of environment-friendly building materials	☐	☐	☐	☐	☐
Purchase of building materials locally produced	☐	☐	☐	☐	☐
Purchase of reclaimed building materials	☐	☐	☐	☐	☐
Purchase of recycled building materials	☐	☐	☐	☐	☐

End of Block: Environment friendly building construction attitudes

Start of Block: Influential factors

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Q22 Please select the option that best describes your opinion for each statement. (Please tick one for each statement)

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Construction is the one of the most polluting industry.	☐	☐	☐	☐	☐
People are more concerned about reuse or recycling these days.	☐	☐	☐	☐	☐
People usually buy environment friendly products in order to feel good.	☐	☐	☐	☐	☐
Price plays an important role in buying environment friendly building materials and products.	☐	☐	☐	☐	☐
Reclaimed and recycled building materials and products are usually available in your nearby suppliers' stores.	☐	☐	☐	☐	☐
Advertisements have effect on people's buying behaviour of reclaimed and recycled building materials and products.	☐	☐	☐	☐	☐
Required information for deciding on reclaimed and recycled building materials and products are easily accessible.	☐	☐	☐	☐	☐
You can easily find specifications of reclaimed and recycled building materials and products.	☐	☐	☐	☐	☐
People usually decide to buy environment friendly products based on advertisements.	☐	☐	☐	☐	☐
People normally find any reclaimed and recycled building materials and products or something similar that they want from suppliers near their living areas.	☐	☐	☐	☐	☐
People purchase behaviour of environment friendly products are based on price to a great extent.	☐	☐	☐	☐	☐
Buying environment friendly products will bring self-satisfaction.	☐	☐	☐	☐	☐
Everyone has some people around who have environment friendly behaviours.	☐	☐	☐	☐	☐
Benefits of reclaimed and recycled building materials and products are more than their drawbacks.	☐	☐	☐	☐	☐

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Q36 How do you evaluate the importance of using reclaimed and recycled building materials? (Please order items by writing a number– 1 being the most important, 3 being the least).

Environmental	
Economical	
Social	

Q37 If you think there is another benefit in using reclaimed or recycled building materials that is not mentioned above, please specify here, in your own words.

End of Block: Influential factors

Start of Block: manufacturer

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Q38 Please select the option that best describes your opinion for each statement. (Please tick one for each statement)

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
The public image of the company is important when buying an environment-friendly product.	☐	☐	☐	☐	☐
Environment-friendly companies know what their consumers want.	☐	☐	☐	☐	☐
The environmental image of the company is important when buying an environment-friendly product	☐	☐	☐	☐	☐
There is a gap between environment-friendly companies' claim and performance.	☐	☐	☐	☐	☐
Environment-friendly companies communicate enough with people.	☐	☐	☐	☐	☐

End of Block: manufacturer

Start of Block: NGO

Q43 Have you ever participated in environment friendly activities related to reclaimed and/or recycled building materials? (Please tick one).

☐ Yes

☐ No

Skip To: Q45 If Q43 = No

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Q44 What environmental activities best describe your participation related to reuse and recycling (present or past)? Please tick as many as you need to best describe your role.

☐ fundraising

☐ Creating a network

☐ Social movement

☐ Assessing the environmental impacts

☐ Effective voice

☐ Other, please specify _____

End of Block: NGO

Start of Block: Regulations

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Q45 Please select the option that best describes your opinion for each statement.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
There are enough regulations related to reclaimed and recycled building materials.	☐	☐	☐	☐	☐
You have knowledge about regulations related to the use of reclaimed and/or recycled products in building construction process.	☐	☐	☐	☐	☐
There are enough building certificates related to reclaimed and recycled building materials.	☐	☐	☐	☐	☐
There are enough building material certificates related to reclaimed and recycled building materials.	☐	☐	☐	☐	☐

Q49 How do you evaluate the importance of specifications of building materials (When purchasing reclaimed and recycled building materials)? (Please order items by writing a number– 1 being the most important, 6 being the least).

Health	
Durability	
Cost	
Quality and performance	
Environmental impacts	
Safety	
Other, please specify	

End of Block: Regulations

Start of Block: Environment friendly behaviours

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Q50 Please select any practice in the following list that you participate in. Please tick as many as you need to best describe your role.

- ☐ Recycling paper, plastic, glass bottles, cardboard, aluminium cans, or other products
- ☐ Repairing items as much as possible
- ☐ Reusing different products
- ☐ Reduction of waste generation
- ☐ Selection of products based on carbon footprint
- ☐ Buying energy-efficient products
- ☐ Purchase of environment-friendly products
- ☐ Buying recycled products
- ☐ Buying items from flea market
- ☐ Purchase or build energy-efficient buildings
- ☐ Purchase or build sustainable buildings
- ☐ Purchase or build buildings with less carbon footprint
- ☐ Purchase of environment-friendly building materials

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- ☐ Purchase of building materials locally produced
- ☐ Purchase of building materials with less carbon footprint
- ☐ Purchase of reclaimed building materials
- ☐ Purchase of recycled building materials

End of Block: Environment friendly behaviours

Start of Block: Importance of stakeholders' roles

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Q51 Please answer each of the following questions by selecting the option that best describes your opinion. (Please tick one)

	consumer	manufacturers and salvage industry	architects	regulators	NGOs (or environmental activists)	builders
Who has a more important role in enhancing reuse and recycling of building materials?	☐	☐	☐	☐	☐	☐
Who do you think plays the most significant role in changing attitudes for reuse and recycling of building materials?	☐	☐	☐	☐	☐	☐
Who has the most significant role in implementing the use of recycled building materials in the industry?	☐	☐	☐	☐	☐	☐
Who has more important role in checking the safety and performance of reclaimed and recycled building materials in building construction process?	☐	☐	☐	☐	☐	☐
Who do you believe has more important role in including consumers' ideas of using reclaimed and recycled building materials in buildings?	☐	☐	☐	☐	☐	☐

End of Block: Importance of stakeholders' roles

Start of Block: Roles

Q56 Do you have a role in enhancing reuse and recycling of building materials?

- ☐ Yes
- ☐ No

Skip To: Q58 If Q56 = No

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Q57 how would you describe your role in enhancing reuse and recycling of building materials? Please specify in your own words.

Q58 Please answer each of the following questions by selecting one option.

	Yes	No
Do you know other stakeholders' roles in the market of reclaimed and recycled building materials?	☐	☐
Do you have knowledge about related regulations to reuse and recycling of building materials which is related to your occupation too?	☐	☐
Do you have an occupation that has an effect on increasing the use of reclaimed and recycled building materials?	☐	☐
Should you agree with using reclaimed and recycled building materials according to your professional responsibilities?	☐	☐
Would you suggest to others to use reclaimed and recycled building materials?	☐	☐

End of Block: Roles

Start of Block: Problems

Q63 Is there anything else you feel is relevant to this study? Were there any specific questions in this questionnaire that you found difficult to answer? If yes, please identify them and explain why.

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End of Block: Problems

Start of Block: Focus group participation

Q64 If you are willing to participate further in this research by taking part in a focus group, please click yes. This will take you to another page with a link, then click the link to enter your contact information. This will help us finalize the results of this survey based on your insight. (If you give your contact information you will be included in a prize draw and you will receive information on the conclusions of the research)

☐ Yes

☐ No

Skip To: Contact information If Q64 = Yes

End of Block: Focus group participation

Start of Block: Thank you

Thank you for taking this survey. Your answers are a valuable part of this research.

End of Block: Thank you

Contact information

Name:

Email:

Number:

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Appendix 5

Ethics approvals

VICTORIA UNIVERSITY OF
WELLINGTON
TE HERENGA WAKA

Phone 0-4-463 6028
Email judith.loveridge@vuw.ac.nz

TO	Zahra Balador
FROM	Associate Professor Judith Loveridge, Convenor, Human Ethics Committee
DATE	26 March 2018
PAGES	1
SUBJECT	Ethics Approval Number: 25492 Title: Stakeholders' roles in enhancing the reuse and recycling of building materials in New Zealand.

Thank you for your application for ethical approval, which has now been considered by the Human Ethics Committee.

Your application has been approved from the above date and this approval is valid for three years. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Kind regards,

Judith Loveridge

Convenor, Victoria University of Wellington Human Ethics Committee

TO	Zahra Balador
FROM	Associate Professor Judith Loveridge, Convenor, Human Ethics Committee
DATE	22 August 2018
PAGES	1
SUBJECT	Ethics Approval Number: 28502 Title: The role of architects in increasing the use of reclaimed and recycled building materials in New Zealand

Thank you for your application to amend your ethics approval. This has now been considered and the request granted.

In the case of an amendment, this approval is valid until the end date of your original ethics approval; in the case of an extension, this approval applies until the new end date that you have nominated. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Kind regards,

Judith Loveridge

Convenor, Victoria University of Wellington Human Ethics Committee

Appendix 6

SPSS results

NEP scale

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
env1	666	1	5	2976	4.47	.777
env2	666	1	5	2971	4.46	.831
env3	666	1	5	2901	4.36	1.016
Q10_4_rev3	666	1	5	2613	3.92	1.251
Q10_5_rev3	666	1	5	2759	4.14	1.210
Q10_6_rev3	666	1	5	2818	4.23	1.207
Valid N (listwise)	666					

score	Frequency	Percent	Valid Percent
9	1	0.2	0.2
12	1	0.2	0.2
13	2	0.3	0.3
14	2	0.3	0.3
15	2	0.3	0.3
16	6	0.9	0.9
17	6	0.9	0.9
18	19	2.9	2.9
19	23	3.5	3.5
20	16	2.4	2.4
21	25	3.8	3.8
22	33	5	5
23	46	6.9	6.9
24	43	6.5	6.5
25	51	7.7	7.7
26	76	11.5	11.5
27	55	8.3	8.3
28	62	9.4	9.4
29	67	10.1	10.1
30	126	19	19
Total	662	100	100

	N	Mean
Secondary	48	4.0382
Training	194	4.1976
Bachelor	197	4.3832
Postgrad	211	4.2828
None	12	3.9722

	anti- ecological	mid- ecological	pro- ecological
Secondary school (college) (n=48)	12.5	35.4	52.1
Trade/technical/vocational training (n=194)	5.7	34	60.3
Bachelor's degree (n=197)	4.6	22.3	73.1
Post graduate degree (n=211)	5.2	27	67.8
None of the above (n=12)	16.7	16.7	66.7

Building material manufacturers or suppliers	4.1052
Builders or contractors	4.218
Architects or designers	4.2904
Environmentalists	4.5353
Related organizations to certificates and regulations	4.3924
Consumer	4.26

Theory of planned behavior

Correlation

			Correlations							
			NEP	PBC1	PBC2	Int1	Int2	Beh1	Beh2	SN
Kendall's tau_b	NEP	Correlation Coefficient	1.000	.033	-.058	.292**	.228**	.246**	.240**	.083
		Sig. (2-tailed)	.	.580	.346	.000	.000	.000	.000	.186
		N	159	150	142	156	156	138	119	150
	PBC1	Correlation Coefficient	.033	1.000	.035	.133*	.155*	.024	-.031	.148*
		Sig. (2-tailed)	.580	.	.568	.039	.013	.714	.646	.018
		N	150	150	142	150	150	138	119	150
	PBC2	Correlation Coefficient	-.058	.035	1.000	-.042	-.091	.088	.117	.022
		Sig. (2-tailed)	.346	.568	.	.527	.160	.175	.089	.738
		N	142	142	142	142	142	138	119	142
	Int1	Correlation Coefficient	.292**	.133*	-.042	1.000	.551**	.334**	.291**	.101
		Sig. (2-tailed)	.000	.039	.527	.	.000	.000	.000	.139
		N	156	150	142	156	156	138	119	150
	Int2	Correlation Coefficient	.228**	.155*	-.091	.551**	1.000	.320**	.231**	.108
		Sig. (2-tailed)	.000	.013	.160	.000	.	.000	.001	.103
		N	156	150	142	156	156	138	119	150
	Beh1	Correlation Coefficient	.246**	.024	.088	.334**	.320**	1.000	.473**	.084
		Sig. (2-tailed)	.000	.714	.175	.000	.000	.	.000	.217
		N	138	138	138	138	138	138	118	138
	Beh2	Correlation Coefficient	.240**	-.031	.117	.291**	.231**	.473**	1.000	.121
		Sig. (2-tailed)	.000	.646	.089	.000	.001	.000	.	.092
		N	119	119	119	119	119	118	119	119
	SN	Correlation Coefficient	.083	.148*	.022	.101	.108	.084	.121	1.000
		Sig. (2-tailed)	.186	.018	.738	.139	.103	.217	.092	.
		N	150	150	142	150	150	138	119	150

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Regression

Assumptions:

- Linearity – the relationships between the predictors and the outcome variable should be linear. Big deal if violated.
- Homogeneity of variance (homoscedasticity) – the error variance should be constant. Not as big a deal if violated.
- Normality – the errors should be normally distributed – normality is necessary for the b-coefficient tests to be valid (especially for small samples), estimation of the coefficients only requires that the errors be identically and independently distributed. Not as big a deal if violated.
- Independence – the errors associated with one observation are not correlated with the errors of any other observation. Huge deal if violated!
- Model specification – the model should be properly specified (including all relevant variables, and excluding irrelevant variables)

Additionally, there are issues that can arise during the analysis that, while strictly speaking are not assumptions of regression, are nonetheless, of great concern to regression analysts.

- Multicollinearity – predictors that are highly related to each other and both predictive of your outcome, can cause problems in estimating the regression coefficients.
- Unusual and Influential Data

Architects TPB

Descriptive Statistics

	Mean	Std. Deviation	N
Int1	4.5493	.62164	142
PBC1	2.9701	.43935	142
PBC2	2.5440	.69337	142
NEP	4.2981	.56522	142
SN	3.6831	.66705	142

Correlations

		Int1	PBC1	PBC2	NEP	SN
Pearson Correlation	Int1	1.000	.111	-.052	.284	.078
	PBC1	.111	1.000	.076	-.035	.182
	PBC2	-.052	.076	1.000	-.095	.063
	NEP	.284	-.035	-.095	1.000	.092
	SN	.078	.182	.063	.092	1.000
Sig. (1-tailed)	Int1	.	.093	.268	.000	.179
	PBC1	.093	.	.183	.341	.015
	PBC2	.268	.183	.	.131	.228
	NEP	.000	.341	.131	.	.137
	SN	.179	.015	.228	.137	.
N	Int1	142	142	142	142	142
	PBC1	142	142	142	142	142
	PBC2	142	142	142	142	142
	NEP	142	142	142	142	142
	SN	142	142	142	142	142

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	NEP	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Int1

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.284 ^a	.081	.074	.59814	.081	12.301	1	140	.001	1.841

a. Predictors: (Constant), NEP

b. Dependent Variable: Int1

Independence of observations:

The Durbin-Watson statistic is between 1.5 and 2.5 and therefore the data is not autocorrelated.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.401	1	4.401	12.301	.001 ^b
	Residual	50.087	140	.358		
	Total	54.488	141			

a. Dependent Variable: Int1

b. Predictors: (Constant), NEP

Multicollinearity:

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.206	.386		8.298	.000	2.442	3.970		
	NEP	.313	.089	.284	3.507	.001	.136	.489	1.000	1.000

a. Dependent Variable: Int1

VIF value is below 10, indicating that the multicollinearity assumption is met.

Excluded Variables^a

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	PBC1	.121 ^b	1.505	.135	.127	.999	1.001	.999
	PBC2	-.026 ^b	-.314	.754	-.027	.991	1.009	.991
	SN	.052 ^b	.638	.525	.054	.991	1.009	.991

a. Dependent Variable: Int1

b. Predictors in the Model: (Constant), NEP

Collinearity Diagnostics^a

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions	
				(Constant)	NEP
1	1	1.992	1.000	.00	.00
	2	.008	15.328	1.00	1.00

a. Dependent Variable: Int1

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	4.1435	4.7687	4.5459	.17856	156
Residual	-3.66449	.85645	-.02030	.59110	156
Std. Predicted Value	-2.297	1.242	-.019	1.011	156
Std. Residual	-6.127	1.432	-.034	.988	156

a. Dependent Variable: Int1

Normality:

Even though is slightly skewed, it is not a huge deviation from a normal distribution, so this distribution satisfies the normality assumption.

We can assume linearity is met as long as there are no drastic deviations.

Regression of Int2:

Descriptive Statistics

	Mean	Std. Deviation	N
Int2	4.3028	.65942	142
PBC1	2.9701	.43935	142
PBC2	2.5440	.69337	142
NEP	4.2981	.56522	142
SN	3.6831	.66705	142

Correlations

		Int2	PBC1	PBC2	NEP	SN
Pearson Correlation	Int2	1.000	.170	-.054	.216	.150
	PBC1	.170	1.000	.076	-.035	.182
	PBC2	-.054	.076	1.000	-.095	.063
	NEP	.216	-.035	-.095	1.000	.092
	SN	.150	.182	.063	.092	1.000
Sig. (1-tailed)	Int2	.	.021	.262	.005	.038
	PBC1	.021	.	.183	.341	.015
	PBC2	.262	.183	.	.131	.228
	NEP	.005	.341	.131	.	.137
	SN	.038	.015	.228	.137	.
N	Int2	142	142	142	142	142
	PBC1	142	142	142	142	142
	PBC2	142	142	142	142	142
	NEP	142	142	142	142	142
	SN	142	142	142	142	142

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	NEP		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	PBC1		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Int2

Model Summary^c

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.216 ^a	.047	.040	.64616	.047	6.846	1	140	.010	
2	.280 ^b	.078	.065	.63764	.032	4.767	1	139	.031	1.922

a. Predictors: (Constant), NEP

b. Predictors: (Constant), NEP, PBC1

c. Dependent Variable: Int2

Independence of observations:

The Durbin-Watson statistic is between 1.5 and 2.5 and therefore the data is not autocorrelated.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.858	1	2.858	6.846	.010 ^b
	Residual	58.454	140	.418		
	Total	61.312	141			
2	Regression	4.797	2	2.398	5.899	.003 ^c
	Residual	56.515	139	.407		
	Total	61.312	141			

a. Dependent Variable: Int2

b. Predictors: (Constant), NEP

c. Predictors: (Constant), NEP, PBC1

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error				Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.220	.417		7.716	.000	2.395	4.045		
	NEP	.252	.096	.216	2.617	.010	.062	.442	1.000	1.000
2	(Constant)	2.396	.559		4.290	.000	1.292	3.501		
	NEP	.259	.095	.222	2.726	.007	.071	.447	.999	1.001
	PBC1	.267	.122	.178	2.183	.031	.025	.509	.999	1.001

a. Dependent Variable: Int2

VIF value is below 10, indicating that the multicollinearity assumption is met.

Excluded Variables^a

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	PBC1	.178 ^b	2.183	.031	.182	.999	1.001	.999
	PBC2	-.034 ^b	-.406	.685	-.034	.991	1.009	.991
	SN	.131 ^b	1.589	.114	.134	.991	1.009	.991
2	PBC2	-.047 ^c	-.573	.567	-.049	.986	1.015	.986
	SN	.101 ^c	1.218	.225	.103	.957	1.045	.957

a. Dependent Variable: Int2

b. Predictors in the Model: (Constant), NEP

c. Predictors in the Model: (Constant), NEP, PBC1

Collinearity Diagnostics^a

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions		
				(Constant)	NEP	PBC1
1	1	1.992	1.000	.00	.00	
	2	.008	15.328	1.00	1.00	
2	1	2.974	1.000	.00	.00	.00
	2	.020	12.240	.00	.38	.59
	3	.006	22.129	1.00	.62	.41

a. Dependent Variable: Int2

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.7840	4.7263	4.3045	.19119	150
Residual	-1.98263	1.12963	-.02003	.63985	150
Std. Predicted Value	-2.813	2.296	.009	1.037	150
Std. Residual	-3.109	1.772	-.031	1.003	150

a. Dependent Variable: Int2

Even though it is slightly skewed, it is not a huge deviation from a normal distribution, so this distribution satisfies the normality assumption.

We can assume linearity is met as long as there are no drastic deviations.

Regression of Beh1:

Descriptive Statistics

	Mean	Std. Deviation	N
Beh1	6.0000	1.85614	138
PBC1	2.9656	.43689	138
PBC2	2.5254	.69164	138
NEP	4.3007	.56452	138
SN	3.6739	.66906	138
Int1	4.5459	.62256	138
Int2	4.2995	.66091	138

Correlations

		Beh1	PBC1	PBC2	NEP	SN	Int1	Int2
Pearson Correlation	Beh1	1.000	.066	.121	.329	.147	.396	.444
	PBC1	.066	1.000	.072	-.058	.174	.095	.176
	PBC2	.121	.072	1.000	-.086	.057	-.047	-.047
	NEP	.329	-.058	-.086	1.000	.076	.274	.220
	SN	.147	.174	.057	.076	1.000	.065	.148
	Int1	.396	.095	-.047	.274	.065	1.000	.593
	Int2	.444	.176	-.047	.220	.148	.593	1.000
Sig. (1-tailed)	Beh1	.	.220	.079	.000	.043	.000	.000
	PBC1	.220	.	.202	.251	.021	.133	.019
	PBC2	.079	.202	.	.158	.252	.294	.291
	NEP	.000	.251	.158	.	.187	.001	.005
	SN	.043	.021	.252	.187	.	.223	.041
	Int1	.000	.133	.294	.001	.223	.	.000
	Int2	.000	.019	.291	.005	.041	.000	.
N	Beh1	138	138	138	138	138	138	138
	PBC1	138	138	138	138	138	138	138
	PBC2	138	138	138	138	138	138	138
	NEP	138	138	138	138	138	138	138
	SN	138	138	138	138	138	138	138
	Int1	138	138	138	138	138	138	138
	Int2	138	138	138	138	138	138	138

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	Int2		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	NEP		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	PBC2		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Beh1

Model Summary^d

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics				Sig. F Change	Durbin-Watson
						F Change	df1	df2			
1	.444 ^a	.197	.191	1.66900	.197	33.445	1	136		.000	
2	.503 ^b	.253	.242	1.61565	.056	10.130	1	135		.002	
3	.528 ^c	.279	.263	1.59333	.026	4.809	1	134		.030	2.057

a. Predictors: (Constant), Int2

b. Predictors: (Constant), Int2, NEP

c. Predictors: (Constant), Int2, NEP, PBC2

d. Dependent Variable: Beh1

Independence of observations:

The Durbin-Watson statistic is between 1.5 and 2.5 and therefore the data is not autocorrelated.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	93.164	1	93.164	33.445	.000 ^b
	Residual	378.836	136	2.786		
	Total	472.000	137			
2	Regression	119.607	2	59.803	22.910	.000 ^c
	Residual	352.393	135	2.610		
	Total	472.000	137			
3	Regression	131.816	3	43.939	17.308	.000 ^d
	Residual	340.184	134	2.539		
	Total	472.000	137			

a. Dependent Variable: Beh1

b. Predictors: (Constant), Int2

c. Predictors: (Constant), Int2, NEP

d. Predictors: (Constant), Int2, NEP, PBC2

Coefficients ^a										
		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.635	.938		.677	.500	-1.220	2.491		
	Int2	1.248	.216	.444	5.783	.000	.821	1.674	1.000	1.000
2	(Constant)	-2.152	1.262		-1.705	.090	-4.647	.344		
	Int2	1.098	.214	.391	5.128	.000	.675	1.521	.952	1.051
	NEP	.798	.251	.243	3.183	.002	.302	1.293	.952	1.051
3	(Constant)	-3.486	1.385		-2.517	.013	-6.225	-.746		
	Int2	1.111	.211	.396	5.262	.000	.694	1.529	.951	1.052
	NEP	.840	.248	.255	3.388	.001	.350	1.330	.946	1.057
	PBC2	.433	.198	.161	2.193	.030	.043	.824	.992	1.008

a. Dependent Variable: Beh1

VIF value is below 10, indicating the multicollinearity assumption is met.

Excluded Variables ^a								
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	PBC1	-.012 ^b	-.156	.876	-.013	.969	1.032	.969
	PBC2	.142 ^b	1.865	.064	.159	.998	1.002	.998
	NEP	.243 ^b	3.183	.002	.264	.952	1.051	.952
	SN	.083 ^b	1.068	.287	.092	.978	1.022	.978
	Int1	.204 ^b	2.168	.032	.183	.648	1.543	.648
2	PBC1	.012 ^c	.158	.875	.014	.959	1.042	.916
	PBC2	.161 ^c	2.193	.030	.186	.992	1.008	.946
	SN	.072 ^c	.959	.339	.083	.976	1.025	.934
	Int1	.156 ^c	1.668	.098	.143	.627	1.596	.627
3	PBC1	.000 ^d	-.002	.998	.000	.954	1.048	.914
	SN	.061 ^d	.822	.412	.071	.971	1.029	.933
	Int1	.158 ^d	1.712	.089	.147	.627	1.596	.627

a. Dependent Variable: Beh1

b. Predictors in the Model: (Constant), Int2

c. Predictors in the Model: (Constant), Int2, NEP

d. Predictors in the Model: (Constant), Int2, NEP, PBC2

Collinearity Diagnostics^a

Model	Dimension	Eigenvalue	Condition Index	(Constant)	Variance Proportions		
					Int2	NEP	PBC2
1	1	1.988	1.000	.01	.01		
	2	.012	13.134	.99	.99		
2	1	2.976	1.000	.00	.00	.00	
	2	.016	13.656	.02	.83	.36	
	3	.008	19.633	.97	.17	.64	
3	1	3.917	1.000	.00	.00	.00	.00
	2	.060	8.089	.00	.05	.03	.85
	3	.016	15.714	.02	.79	.40	.01
	4	.007	24.044	.98	.17	.57	.14

a. Dependent Variable: Beh1

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.1872	7.7883	6.0000	.98090	138
Residual	-4.87291	3.08914	.00000	1.57578	138
Std. Predicted Value	-3.887	1.823	.000	1.000	138
Std. Residual	-3.058	1.939	.000	.989	138

a. Dependent Variable: Beh1

Even though it is slightly skewed, it is not a huge deviation from a normal distribution, so this distribution satisfies the normality assumption.

We can assume linearity is met as long as there are no drastic deviations.

Regression of Beh2:

Descriptive Statistics

	Mean	Std. Deviation	N
Beh2	4.8739	2.44448	119
PBC1	2.9685	.43794	119
PBC2	2.5525	.68726	119
NEP	4.3389	.54932	119
SN	3.6933	.65454	119
Int1	4.5238	.64887	119
Int2	4.2745	.67599	119

Correlations

		Beh2	PBC1	PBC2	NEP	SN	Int1	Int2
Pearson Correlation	Beh2	1.000	-.006	.128	.334	.153	.297	.301
	PBC1	-.006	1.000	.066	-.042	.110	.095	.185
	PBC2	.128	.066	1.000	-.077	.069	-.029	-.039
	NEP	.334	-.042	-.077	1.000	.107	.342	.285
	SN	.153	.110	.069	.107	1.000	.062	.106
	Int1	.297	.095	-.029	.342	.062	1.000	.625
	Int2	.301	.185	-.039	.285	.106	.625	1.000
Sig. (1-tailed)	Beh2	.	.475	.083	.000	.048	.001	.000
	PBC1	.475	.	.237	.326	.117	.153	.022
	PBC2	.083	.237	.	.204	.228	.377	.337
	NEP	.000	.326	.204	.	.123	.000	.001
	SN	.048	.117	.228	.123	.	.251	.126
	Int1	.001	.153	.377	.000	.251	.	.000
	Int2	.000	.022	.337	.001	.126	.000	.
N	Beh2	119	119	119	119	119	119	119
	PBC1	119	119	119	119	119	119	119
	PBC2	119	119	119	119	119	119	119
	NEP	119	119	119	119	119	119	119
	SN	119	119	119	119	119	119	119
	Int1	119	119	119	119	119	119	119
	Int2	119	119	119	119	119	119	119

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	NEP		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Int2		Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: Beh2

Model Summary^c

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.334 ^a	.112	.104	2.31396	.112	14.687	1	117	.000	
2	.397 ^b	.158	.143	2.26251	.046	6.382	1	116	.013	2.310

a. Predictors: (Constant), NEP

b. Predictors: (Constant), NEP, Int2

c. Dependent Variable: Beh2

Independence of observations:

The Durbin-Watson statistic is between 1.5 and 2.5 and therefore the data is not autocorrelated.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	78.642	1	78.642	14.687	.000 ^b
	Residual	626.467	117	5.354		
	Total	705.109	118			
2	Regression	111.312	2	55.656	10.873	.000 ^c
	Residual	593.797	116	5.119		
	Total	705.109	118			

a. Dependent Variable: Beh2

b. Predictors: (Constant), NEP

c. Predictors: (Constant), NEP, Int2

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-1.574	1.696		-.928	.355	-4.933	1.784		
	NEP	1.486	.388	.334	3.832	.000	.718	2.254	1.000	1.000
2	(Constant)	-3.810	1.880		-2.027	.045	-7.533	-.087		
	NEP	1.201	.396	.270	3.037	.003	.418	1.985	.919	1.088
	Int2	.812	.321	.225	2.526	.013	.175	1.449	.919	1.088

a. Dependent Variable: Beh2

VIF value is below 10, indicating that the multicollinearity assumption is met.

Collinearity Diagnostics^a

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	PBC3	NEP	Int2
1	1	1.981	1.000	.01	.01		
	2	.019	10.204	.99	.99		
2	1	2.962	1.000	.00	.00	.00	
	2	.031	9.739	.02	.75	.17	
	3	.006	21.461	.98	.25	.83	
3	1	3.942	1.000	.00	.00	.00	.00
	2	.037	10.281	.00	.69	.04	.12
	3	.015	16.402	.02	.04	.41	.79
	4	.006	25.465	.98	.27	.54	.09

a. Dependent Variable: Beh2

Excluded Variables^a

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	PBC1	.008 ^b	.094	.925	.009	.998	1.002	.998
	PBC2	.154 ^b	1.779	.078	.163	.994	1.006	.994
	SN	.119 ^b	1.359	.177	.125	.989	1.012	.989
	Int1	.207 ^b	2.268	.025	.206	.883	1.132	.883
	Int2	.225 ^b	2.526	.013	.228	.919	1.088	.919
2	PBC1	-.038 ^c	-.429	.669	-.040	.956	1.046	.880
	PBC2	.158 ^c	1.868	.064	.172	.994	1.006	.915
	SN	.102 ^c	1.192	.236	.110	.982	1.018	.913
	Int1	.110 ^c	.987	.326	.092	.581	1.722	.581

a. Dependent Variable: Beh2

b. Predictors in the Model: (Constant), NEP

c. Predictors in the Model: (Constant), NEP, Int2

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.8188	6.2573	4.8739	.97125	119
Residual	-4.45634	4.28646	.00000	2.24325	119
Std. Predicted Value	-3.146	1.424	.000	1.000	119
Std. Residual	-1.970	1.895	.000	.991	119

a. Dependent Variable: Beh2

Even though it is slightly skewed, it is not a huge deviation from being a normal distribution, so this distribution satisfies the normality assumption.

We can assume linearity is met as long as there are no drastic deviations.

The same statistical process has been done for other stakeholders and the whole sample.

Effect of socio demographic and occupation on Behaviour

Group Statistics

	gender	N	Mean	Std. Deviation	Std. Error Mean
Beh1	Male	381	5.4619	2.00177	.10255
	Female	198	6.4394	1.69018	.12012
Beh2	Male	308	4.2532	2.34086	.13338
	Female	110	4.1364	2.43249	.23193

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Beh1	Equal variances assumed	14.247	.000	-5.869	577	.000	-.97745	.16656	-1.30458	-.65032
	Equal variances not assumed			-6.189	461.703	.000	-.97745	.15794	-1.28782	-.66708
Beh2	Equal variances assumed	.302	.583	.445	416	.657	.11688	.26272	-.39953	.63330
	Equal variances not assumed			.437	185.809	.663	.11688	.26755	-.41094	.64471

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Beh1	18-29 years old	73	5.8904	2.10530	.24641	5.3992	6.3816	1.00	8.00
	30-49 years old	283	5.8092	1.94398	.11556	5.5817	6.0367	1.00	8.00
	50-64 years old	166	5.7229	1.89297	.14692	5.4328	6.0130	1.00	8.00
	65 years and over	57	5.8246	2.03648	.26974	5.2842	6.3649	1.00	8.00
	Total	579	5.7962	1.95536	.08126	5.6366	5.9558	1.00	8.00
Beh2	18-29 years old	38	3.6579	2.45254	.39785	2.8518	4.4640	1.00	8.00
	30-49 years old	198	4.3081	2.35246	.16718	3.9784	4.6378	1.00	8.00
	50-64 years old	140	4.3143	2.36608	.19997	3.9189	4.7097	1.00	8.00
	65 years and over	42	4.0238	2.32156	.35823	3.3004	4.7473	1.00	8.00
	Total	418	4.2225	2.36294	.11558	3.9953	4.4497	1.00	8.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Beh1	.567	3	575	.637
Beh2	.174	3	414	.914

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Beh1	Between Groups	1.634	3	.545	.142	.935
	Within Groups	2208.318	575	3.841		
	Total	2209.952	578			
Beh2	Between Groups	16.401	3	5.467	.979	.403
	Within Groups	2311.907	414	5.584		
	Total	2328.309	417			

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Beh1	Secondary school (college)	37	5.2973	2.07986	.34193	4.6038	5.9908	1.00	8.00
	Trade/technical/vocational training	178	5.3764	1.83774	.13774	5.1046	5.6482	1.00	8.00
	Bachelor's degree	169	6.1243	1.93402	.14877	5.8306	6.4180	1.00	8.00
	Post graduate degree	188	6.0426	1.95902	.14288	5.7607	6.3244	1.00	8.00
	None of the above	7	4.5714	2.22539	.84112	2.5133	6.6296	1.00	7.00
	Total	579	5.7962	1.95536	.08126	5.6366	5.9558	1.00	8.00
Beh2	Secondary school (college)	19	3.9474	2.04053	.46813	2.9639	4.9309	1.00	8.00
	Trade/technical/vocational training	140	4.0286	2.30090	.19446	3.6441	4.4131	1.00	8.00
	Bachelor's degree	124	4.6290	2.44440	.21951	4.1945	5.0635	1.00	8.00
	Post graduate degree	131	4.0611	2.39472	.20923	3.6471	4.4750	1.00	8.00
	None of the above	4	5.0000	1.15470	.57735	3.1626	6.8374	4.00	6.00
	Total	418	4.2225	2.36294	.11558	3.9953	4.4497	1.00	8.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Beh1	.378	4	574	.824
Beh2	1.789	4	413	.130

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Beh1	Between Groups	80.677	4	20.169	5.437	.000
	Within Groups	2129.275	574	3.710		
	Total	2209.952	578			
Beh2	Between Groups	33.029	4	8.257	1.486	.206
	Within Groups	2295.280	413	5.558		
	Total	2328.309	417			

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) education	(J) education	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Beh1	Secondary school (college)	Trade/technical/vocational training	-.07911	.34799	.999	-1.0314	.8732
		Bachelor's degree	-.82696	.34958	.126	-1.7836	.1297
		Post graduate degree	-.74526	.34639	.200	-1.6932	.2026
		None of the above	.72587	.79385	.891	-1.4465	2.8982
	Trade/technical/vocational training	Secondary school (college)	.07911	.34799	.999	-.8732	1.0314
		Bachelor's degree	-.74786*	.20686	.003	-1.3139	-.1818
		Post graduate degree	-.66615*	.20142	.009	-1.2173	-.1150
		None of the above	.80498	.74214	.814	-1.2259	2.8358
	Bachelor's degree	Secondary school (college)	.82696	.34958	.126	-.1297	1.7836
		Trade/technical/vocational training	.74786*	.20686	.003	.1818	1.3139
		Post graduate degree	.08171	.20416	.995	-.4770	.6404
		None of the above	1.55283	.74289	.226	-.4801	3.5857
	Post graduate degree	Secondary school (college)	.74526	.34639	.200	-.2026	1.6932
		Trade/technical/vocational training	.66615*	.20142	.009	.1150	1.2173
		Bachelor's degree	-.08171	.20416	.995	-.6404	.4770
		None of the above	1.47112	.74139	.275	-.5577	3.4999
	None of the above	Secondary school (college)	-.72587	.79385	.891	-2.8982	1.4465
		Trade/technical/vocational training	-.80498	.74214	.814	-2.8358	1.2259
		Bachelor's degree	-1.55283	.74289	.226	-3.5857	.4801
		Post graduate degree	-1.47112	.74139	.275	-3.4999	.5577
Beh2	Secondary school (college)	Trade/technical/vocational training	-.08120	.57637	1.000	-1.6604	1.4980
		Bachelor's degree	-.68166	.58080	.766	-2.2730	.9096
		Post graduate degree	-.11370	.57873	1.000	-1.6993	1.4719
		None of the above	-1.05263	1.29688	.927	-4.6059	2.5006

Trade/technical/vocational training	Secondary school (college)	.08120	.57637	1.000	-1.4980	1.6604
	Bachelor's degree	-.60046	.29072	.237	-1.3970	.1961
	Post graduate degree	-.03250	.28657	1.000	-.8177	.7527
	None of the above	-.97143	1.19545	.927	-4.2468	2.3039
Bachelor's degree	Secondary school (college)	.68166	.58080	.766	-.9096	2.2730
	Trade/technical/vocational training	.60046	.29072	.237	-.1961	1.3970
	Post graduate degree	.56796	.29537	.307	-.2413	1.3772
	None of the above	-.37097	1.19759	.998	-3.6522	2.9103
Post graduate degree	Secondary school (college)	.11370	.57873	1.000	-1.4719	1.6993
	Trade/technical/vocational training	.03250	.28657	1.000	-.7527	.8177
	Bachelor's degree	-.56796	.29537	.307	-1.3772	.2413
	None of the above	-.93893	1.19659	.935	-4.2174	2.3396
None of the above	Secondary school (college)	1.05263	1.29688	.927	-2.5006	4.6059
	Trade/technical/vocational training	.97143	1.19545	.927	-2.3039	4.2468
	Bachelor's degree	.37097	1.19759	.998	-2.9103	3.6522
	Post graduate degree	.93893	1.19659	.935	-2.3396	4.2174

*. The mean difference is significant at the 0.05 level.

Beh1

Tukey HSD^{a,b}

education	N	Subset for alpha = 0.05	
		1	2
None of the above	7	4.5714	
Secondary school (college)	37	5.2973	5.2973
Trade/technical/vocational training	178	5.3764	5.3764
Post graduate degree	188		6.0426
Bachelor's degree	169		6.1243
Sig.		.544	.517

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 26.775.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Descriptives

					95% Confidence Interval for				
				Std.	Std.	Mean			
		N	Mean	Deviation	Error	Lower Bound	Upper Bound	Minimum	Maximum
Beh1	Less than \$19,999	45	5.6000	2.30020	.34289	4.9089	6.2911	1.00	8.00
	\$20,000 to \$39,999	55	5.9818	1.96724	.26526	5.4500	6.5136	1.00	8.00
	\$40,000 to \$79,999	186	6.0430	1.88544	.13825	5.7703	6.3158	1.00	8.00
	\$80,000 to \$109,999	124	5.6290	1.96501	.17646	5.2797	5.9783	1.00	8.00
	\$110,000 or more	169	5.6391	1.91016	.14694	5.3490	5.9291	1.00	8.00
	Total	579	5.7962	1.95536	.08126	5.6366	5.9558	1.00	8.00
Beh2	Less than \$19,999	18	4.6667	2.63461	.62098	3.3565	5.9768	1.00	8.00
	\$20,000 to \$39,999	31	3.6774	2.19677	.39455	2.8716	4.4832	1.00	8.00
	\$40,000 to \$79,999	136	4.1324	2.37521	.20367	3.7296	4.5352	1.00	8.00
	\$80,000 to \$109,999	93	4.2366	2.30970	.23951	3.7609	4.7122	1.00	8.00
	\$110,000 or more	140	4.3643	2.39367	.20230	3.9643	4.7643	1.00	8.00
	Total	418	4.2225	2.36294	.11558	3.9953	4.4497	1.00	8.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Beh1	1.663	4	574	.157
Beh2	.824	4	413	.510

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Beh1	Between Groups	22.596	4	5.649	1.482	.206
	Within Groups	2187.355	574	3.811		
	Total	2209.952	578			
Beh2	Between Groups	16.700	4	4.175	.746	.561
	Within Groups	2311.609	413	5.597		
	Total	2328.309	417			

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Beh1	1	48	5.9792	1.99456	.28789	5.4000	6.5583	1.00	8.00
	2 - 3	305	5.8197	2.00089	.11457	5.5942	6.0451	1.00	8.00
	4 - 5	183	5.8361	1.85028	.13678	5.5662	6.1059	1.00	8.00
	5 or more	43	5.2558	2.00111	.30517	4.6400	5.8717	1.00	8.00
	Total	579	5.7962	1.95536	.08126	5.6366	5.9558	1.00	8.00
Beh2	1	28	4.7143	2.76026	.52164	3.6440	5.7846	1.00	8.00
	2 - 3	215	4.3023	2.33557	.15928	3.9884	4.6163	1.00	8.00
	4 - 5	141	4.1844	2.38328	.20071	3.7876	4.5812	1.00	8.00
	5 or more	34	3.4706	2.00356	.34361	2.7715	4.1697	1.00	8.00
	Total	418	4.2225	2.36294	.11558	3.9953	4.4497	1.00	8.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Beh1	1.394	3	575	.244
Beh2	3.088	3	414	.027

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Beh1	Between Groups	14.622	3	4.874	1.277	.282
	Within Groups	2195.329	575	3.818		
	Total	2209.952	578			
Beh2	Between Groups	27.569	3	9.190	1.654	.176
	Within Groups	2300.739	414	5.557		
	Total	2328.309	417			

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Beh1	auckland	248	5.7419	1.91043	.12131	5.5030	5.9809	1.00	8.00
	wellington	210	5.9048	2.00728	.13852	5.6317	6.1778	1.00	8.00
	christchurch	121	5.7190	1.96309	.17846	5.3657	6.0724	1.00	8.00
	Total	579	5.7962	1.95536	.08126	5.6366	5.9558	1.00	8.00
Beh2	auckland	190	4.1947	2.42539	.17596	3.8476	4.5418	1.00	8.00
	wellington	137	3.9562	2.47597	.21154	3.5379	4.3745	1.00	8.00
	christchurch	91	4.6813	1.98259	.20783	4.2684	5.0942	1.00	8.00
	Total	418	4.2225	2.36294	.11558	3.9953	4.4497	1.00	8.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Beh1	.286	2	576	.751
Beh2	6.789	2	415	.001

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Beh1	Between Groups	3.926	2	1.963	.513	.599
	Within Groups	2206.025	576	3.830		
	Total	2209.952	578			
Beh2	Between Groups	29.018	2	14.509	2.619	.074
	Within Groups	2299.290	415	5.540		
	Total	2328.309	417			

Group Statistics

	owner	N	Mean	Std. Deviation	Std. Error Mean
Beh1	Yes	412	5.7961	1.94002	.09558
	No	167	5.7964	1.99861	.15466
Beh2	Yes	333	4.2312	2.30583	.12636
	No	85	4.1882	2.58887	.28080

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Beh1	Equal variances assumed	.243	.623	-	577	.999	-.00029	.17953	-.35290	.35232
	Equal variances not assumed			-	299.375	.999	-.00029	.18181	-.35807	.35749
Beh2	Equal variances assumed	3.530	.061	.150	416	.881	.04300	.28749	-.52211	.60810
	Equal variances not assumed			.140	120.216	.889	.04300	.30792	-.56666	.65265

Descriptives

		Descriptives							
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Beh1	In a building material manufacturing or salvage/ resale market or sellers of building materials	90	5.0556	1.98512	.20925	4.6398	5.4713	1.00	8.00
	Building practitioner, or working for a builder or a contractor	144	5.3472	1.82185	.15182	5.0471	5.6473	1.00	8.00
	Architect, designer, or working in an architectural firm	138	6.0000	1.85614	.15801	5.6876	6.3124	1.00	8.00
	Environmental activist or working in an environmental NGO or community	44	7.2500	1.39975	.21102	6.8244	7.6756	1.00	8.00
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	44	6.5000	1.62108	.24439	6.0071	6.9929	2.00	8.00
	None of the above, please specify	119	5.8655	2.09084	.19167	5.4860	6.2451	1.00	8.00
	Total	579	5.7962	1.95536	.08126	5.6366	5.9558	1.00	8.00
Beh2	In a building material manufacturing or salvage/ resale market or sellers of building materials	63	3.3016	1.71929	.21661	2.8686	3.7346	1.00	8.00
	Building practitioner, or working for a builder or a contractor	122	4.2131	2.28986	.20731	3.8027	4.6235	1.00	8.00
	Architect, designer, or working in an architectural firm	119	4.8739	2.44448	.22409	4.4302	5.3177	1.00	8.00
	Environmental activist or working in an environmental NGO or community	27	4.1852	2.60232	.50082	3.1557	5.2146	1.00	8.00
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	28	4.9286	2.49338	.47120	3.9617	5.8954	1.00	8.00
	None of the above, please specify	59	3.5932	2.34975	.30591	2.9809	4.2056	1.00	8.00
	Total	418	4.2225	2.36294	.11558	3.9953	4.4497	1.00	8.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Beh1	4.403	5	573	.001
Beh2	4.029	5	412	.001

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Beh1	Between Groups	199.492	5	39.898	11.371	.000
	Within Groups	2010.460	573	3.509		
	Total	2209.952	578			
Beh2	Between Groups	141.302	5	28.260	5.324	.000
	Within Groups	2187.007	412	5.308		
	Total	2328.309	417			

Multiple Comparisons

Tukey HSD

						95% Confidence Interval	
Dependent Variable	(I) occupation	(J) occupation	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Beh1	In a building material manufacturing or salvage/ resale market or sellers of building materials	Building practitioner, or working for a builder or a contractor	-.29167	.25170	.856	-1.0114	.4280
		Architect, designer, or working in an architectural firm	-.94444*	.25379	.003	-1.6701	-.2188
		Environmental activist or working in an environmental NGO or community	-2.19444*	.34457	.000	-3.1797	-1.2092
		In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-1.44444*	.34457	.000	-2.4297	-.4592
		None of the above, please specify	-.80999*	.26167	.025	-1.5582	-.0618
	Building practitioner, or working for a builder or a contractor	In a building material manufacturing or salvage/ resale market or sellers of building materials	.29167	.25170	.856	-.4280	1.0114
		Architect, designer, or working in an architectural firm	-.65278*	.22314	.041	-1.2908	-.0147
		Environmental activist or working in an environmental NGO or community	-1.90278*	.32266	.000	-2.8254	-.9802

	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-1.15278*	.32266	.005	-2.0754	-.2302
	None of the above, please specify	-.51832	.23206	.224	-1.1819	.1452
Architect, designer, or working in an architectural firm	In a building material manufacturing or salvage/ resale market or sellers of building materials	.94444*	.25379	.003	.2188	1.6701
	Building practitioner, or working for a builder or a contractor	.65278*	.22314	.041	.0147	1.2908
	Environmental activist or working in an environmental NGO or community	-1.25000*	.32429	.002	-2.1773	-.3227
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-.50000	.32429	.637	-1.4273	.4273
	None of the above, please specify	.13445	.23433	.993	-.5356	.8045
Environmental activist or working in an environmental NGO or community	In a building material manufacturing or salvage/ resale market or sellers of building materials	2.19444*	.34457	.000	1.2092	3.1797
	Building practitioner, or working for a builder or a contractor	1.90278*	.32266	.000	.9802	2.8254
	Architect, designer, or working in an architectural firm	1.25000*	.32429	.002	.3227	2.1773
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	.75000	.39935	.417	-.3919	1.8919
	None of the above, please specify	1.38445*	.33049	.000	.4394	2.3295

	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	In a building material manufacturing or salvage/ resale market or sellers of building materials	1.44444*	.34457	.000	.4592	2.4297
		Building practitioner, or working for a builder or a contractor	1.15278*	.32266	.005	.2302	2.0754
		Architect, designer, or working in an architectural firm	.50000	.32429	.637	-.4273	1.4273
		Environmental activist or working in an environmental NGO or community	-.75000	.39935	.417	-1.8919	.3919
		None of the above, please specify	.63445	.33049	.391	-.3106	1.5795
	None of the above, please specify	In a building material manufacturing or salvage/ resale market or sellers of building materials	.80999*	.26167	.025	.0618	1.5582
		Building practitioner, or working for a builder or a contractor	.51832	.23206	.224	-.1452	1.1819
		Architect, designer, or working in an architectural firm	-.13445	.23433	.993	-.8045	.5356
		Environmental activist or working in an environmental NGO or community	-1.38445*	.33049	.000	-2.3295	-.4394
		In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-.63445	.33049	.391	-1.5795	.3106
Beh2	In a building material manufacturing or salvage/ resale market or sellers of building materials	Building practitioner, or working for a builder or a contractor	-.91153	.35745	.112	-1.9350	.1119
		Architect, designer, or working in an architectural firm	-1.57236*	.35898	.000	-2.6002	-.5445
		Environmental activist or working in an environmental NGO or community	-.88360	.52996	.554	-2.4010	.6338

	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-1.62698*	.52330	.024	-3.1253	-.1287
	None of the above, please specify	-.29163	.41741	.982	-1.4867	.9035
	Building practitioner, or working for a builder or a contractor	.91153	.35745	.112	-.1119	1.9350
	Architect, designer, or working in an architectural firm	-.66083	.29685	.228	-1.5108	.1891
	Environmental activist or working in an environmental NGO or community	.02793	.49001	1.000	-1.3751	1.4309
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-.71546	.48280	.676	-2.0978	.6669
	None of the above, please specify	.61989	.36535	.535	-.4262	1.6660
	Architect, designer, or working in an architectural firm	1.57236*	.35898	.000	.5445	2.6002
	Building practitioner, or working for a builder or a contractor	.66083	.29685	.228	-.1891	1.5108
	Environmental activist or working in an environmental NGO or community	.68876	.49113	.726	-.7174	2.0950
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-.05462	.48393	1.000	-1.4402	1.3310
	None of the above, please specify	1.28073*	.36685	.007	.2304	2.3311

Environmental activist or working in an environmental NGO or community	In a building material manufacturing or salvage/ resale market or sellers of building materials	.88360	.52996	.554	-.6338	2.4010
	Building practitioner, or working for a builder or a contractor	-.02793	.49001	1.000	-1.4309	1.3751
	Architect, designer, or working in an architectural firm	-.68876	.49113	.726	-2.0950	.7174
	In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-.74339	.62144	.839	-2.5227	1.0359
	None of the above, please specify	.59196	.53533	.879	-.9408	2.1247
In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	In a building material manufacturing or salvage/ resale market or sellers of building materials	1.62698*	.52330	.024	.1287	3.1253
	Building practitioner, or working for a builder or a contractor	.71546	.48280	.676	-.6669	2.0978
	Architect, designer, or working in an architectural firm	.05462	.48393	1.000	-1.3310	1.4402
	Environmental activist or working in an environmental NGO or community	.74339	.62144	.839	-1.0359	2.5227
	None of the above, please specify	1.33535	.52873	.119	-.1785	2.8492
None of the above, please specify	In a building material manufacturing or salvage/ resale market or sellers of building materials	.29163	.41741	.982	-.9035	1.4867
	Building practitioner, or working for a builder or a contractor	-.61989	.36535	.535	-1.6660	.4262
	Architect, designer, or working in an architectural firm	-1.28073*	.36685	.007	-2.3311	-.2304
	Environmental activist or working in an environmental NGO or community	-.59196	.53533	.879	-2.1247	.9408

In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	-1.33535	.52873	.119	-2.8492	.1785
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*. The mean difference is significant at the 0.05 level.

Beh1

Tukey HSD^{a,b}

occupation	N	Subset for alpha = 0.05			
		1	2	3	4
In a building material manufacturing or salvage/ resale market or sellers of building materials	90	5.0556			
Building practitioner, or working for a builder or a contractor	144	5.3472	5.3472		
None of the above, please specify	119	5.8655	5.8655	5.8655	
Architect, designer, or working in an architectural firm	138		6.0000	6.0000	
In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	44			6.5000	6.5000
Environmental activist or working in an environmental NGO or community	44				7.2500
Sig.		.085	.266	.296	.136

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 75.796.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Beh2

Tukey HSD^{a,b}

occupation	N	Subset for alpha = 0.05		
		1	2	3
In a building material manufacturing or salvage/ resale market or sellers of building materials	63	3.3016		
None of the above, please specify	59	3.5932	3.5932	
Environmental activist or working in an environmental NGO or community	27	4.1852	4.1852	4.1852
Building practitioner, or working for a builder or a contractor	122	4.2131	4.2131	4.2131
Architect, designer, or working in an architectural firm	119		4.8739	4.8739
In government, city councils, building certificate organizations or research institutes related to building, waste or environmental regulations	28			4.9286
Sig.		.367	.067	.600

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 49.110.

b. The group sizes are unequal. The harmonic mean of the group sizes is used.

Type I error levels are not guaranteed.

Three pillars of sustainability:

Total N	588
Test Statistic	451.912
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distributions of environmental, economical and social are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Ranks

	occupation	N	Mean Rank
environmental	Manufacturer/supplier	89	299.33
	Builder	149	313.50
	Architect	139	292.33
	Environmentalist	44	256.57
	Regulator	44	280.02
	Consumer	123	289.19
	Total	588	
economic	Manufacturer/supplier	89	277.59
	Builder	149	245.49
	Architect	139	324.67
	Environmentalist	44	386.50
	Regulator	44	293.02
	Consumer	123	299.63
	Total	588	
social	Manufacturer/supplier	89	313.30
	Builder	149	334.25
	Architect	139	256.89
	Environmentalist	44	231.63
	Regulator	44	307.85
	Consumer	123	292.96
	Total	588	

Test Statistics^{a,b}

	environmental	economical	social
Chi-Square	7.456	35.688	30.583
df	5	5	5
Asymp. Sig.	.189	.000	.000

a. Kruskal Wallis Test

b. Grouping Variable: occupation

Regression for prediction of three pillars from demographics:

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	owner, size, education, gender, age, income ^b		. Enter

a. Dependent Variable: environmental

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.104 ^a	.011	.001	.571

a. Predictors: (Constant), owner, size, education, gender, age, income

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.064	6	.344	1.054	.389 ^b
	Residual	189.587	581	.326		
	Total	191.651	587			

a. Dependent Variable: environmental

b. Predictors: (Constant), owner, size, education, gender, age, income

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.369	.239		5.721	.000
	gender	-.079	.055	-.066	-1.437	.151
	age	-.048	.033	-.068	-1.443	.150
	education	.031	.025	.053	1.227	.220
	income	.013	.022	.029	.600	.549
	size	.012	.033	.016	.371	.710
	owner	-.016	.062	-.012	-.253	.800

a. Dependent Variable: environmental

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	gender		. Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	education		. Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	age		. Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: economical

Model Summary^d

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.158 ^a	.025	.023	.724	
2	.187 ^b	.035	.032	.721	
3	.204 ^c	.042	.037	.719	1.926

a. Predictors: (Constant), gender

b. Predictors: (Constant), gender, education

c. Predictors: (Constant), gender, education, age

d. Dependent Variable: economical

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.862	1	7.862	14.982	.000 ^b
	Residual	307.504	586	.525		
	Total	315.366	587			
2	Regression	10.989	2	5.495	10.560	.000 ^c
	Residual	304.377	585	.520		
	Total	315.366	587			
3	Regression	13.142	3	4.381	8.465	.000 ^d
	Residual	302.223	584	.518		
	Total	315.366	587			

a. Dependent Variable: economical

b. Predictors: (Constant), gender

c. Predictors: (Constant), gender, education

d. Predictors: (Constant), gender, education, age

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.787	.090		19.936	.000	1.611	1.963		
	gender	.244	.063	.158	3.871	.000	.120	.368	1.000	1.000
2	(Constant)	1.531	.137		11.156	.000	1.262	1.801		
	gender	.212	.064	.137	3.303	.001	.086	.338	.958	1.044
	education	.076	.031	.102	2.452	.015	.015	.137	.958	1.044
3	(Constant)	1.295	.179		7.229	.000	.943	1.647		
	gender	.239	.065	.155	3.661	.000	.111	.368	.918	1.090
	education	.082	.031	.109	2.623	.009	.021	.143	.951	1.051
	age	.076	.037	.085	2.040	.042	.003	.150	.942	1.061

a. Dependent Variable: economical

Excluded Variables^a

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	age	.076 ^b	1.814	.070	.075	.949	1.054	.949
	education	.102 ^b	2.452	.015	.101	.958	1.044	.958
	income	-.030 ^b	-.686	.493	-.028	.858	1.166	.858
	size	-.034 ^b	-.830	.407	-.034	.992	1.008	.992
	owner	-.064 ^b	-1.547	.123	-.064	.959	1.043	.959
2	age	.085 ^c	2.040	.042	.084	.942	1.061	.918
	income	-.023 ^c	-.528	.597	-.022	.854	1.171	.834
	size	-.025 ^c	-.622	.535	-.026	.985	1.015	.951
	owner	-.081 ^c	-1.945	.052	-.080	.937	1.067	.930
3	income	-.037 ^d	-.837	.403	-.035	.836	1.196	.817
	size	-.010 ^d	-.242	.809	-.010	.950	1.053	.907
	owner	-.057 ^d	-1.260	.208	-.052	.799	1.251	.799

a. Dependent Variable: economical

b. Predictors in the Model: (Constant), gender

c. Predictors in the Model: (Constant), gender, education

d. Predictors in the Model: (Constant), gender, education, age

Collinearity Diagnostics^a

Model	Dimension	Eigenvalue	Condition Index	(Constant)	Variance Proportions		
					gender	education	age
1	1	1.943	1.000	.03	.03		
	2	.057	5.829	.97	.97		
2	1	2.896	1.000	.01	.01	.01	
	2	.075	6.218	.06	.93	.19	
	3	.029	10.042	.94	.05	.80	
3	1	3.780	1.000	.00	.01	.00	.01
	2	.138	5.231	.00	.29	.01	.43
	3	.062	7.823	.01	.55	.49	.17
	4	.020	13.785	.99	.15	.50	.39

a. Dependent Variable: economical

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.77	2.49	2.11	.150	588
Residual	-2.096	1.149	.000	.718	588
Std. Predicted Value	-2.270	2.534	.000	1.000	588
Std. Residual	-2.913	1.598	.000	.997	588

a. Dependent Variable: economical

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	education	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: social

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.202 ^a	.041	.039	.610	1.744

a. Predictors: (Constant), education

b. Dependent Variable: social

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.242	1	9.242	24.817	.000 ^b
	Residual	218.227	586	.372		
	Total	227.469	587			

a. Dependent Variable: social

b. Predictors: (Constant), education

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t		Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.054	.104		29.360	.000	2.849	3.258		
	education	-.128	.026	-.202	-4.982	.000	-.179	-.078	1.000	1.000

a. Dependent Variable: social

Excluded Variables^a

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	gender	-.079 ^b	-1.907	.057	-.079	.958	1.044	.958
	age	-.011 ^b	-.260	.795	-.011	.984	1.016	.984
	income	.044 ^b	1.071	.285	.044	.981	1.019	.981
	size	.012 ^b	.292	.770	.012	.989	1.011	.989
	owner	.046 ^b	1.107	.269	.046	.966	1.035	.966

a. Dependent Variable: social

b. Predictors in the Model: (Constant), education

Collinearity Diagnostics^a

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions	
				(Constant)	education
1	1	1.970	1.000	.01	.01
	2	.030	8.143	.99	.99

a. Dependent Variable: social

Or kruskal wallis test:

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of environmental is the same across categories of gender.	Independent-Samples Kruskal-Wallis Test	.038	Reject the null hypothesis.
2	The distribution of economical is the same across categories of gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of social is the same across categories of gender.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Ranks

	gender	N	Mean Rank
environmental	Male	388	302.69
	Female	200	278.62
	Total	588	
economical	Male	388	276.97
	Female	200	328.51
	Total	588	
social	Male	388	307.87
	Female	200	268.57
	Total	588	

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of environmental is the same across categories of age.	Independent-Samples Kruskal-Wallis Test	.109	Retain the null hypothesis.
2	The distribution of economical is the same across categories of age.	Independent-Samples Kruskal-Wallis Test	.608	Retain the null hypothesis.
3	The distribution of social is the same across categories of age.	Independent-Samples Kruskal-Wallis Test	.284	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of environmental is the same across categories of education.	Independent-Samples Kruskal-Wallis Test	.041	Reject the null hypothesis.
2	The distribution of economical is the same across categories of education.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of social is the same across categories of education.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Ranks

	education	N	Mean Rank
environmental	Secondary school (college)	40	268.70
	Trade/technical/vocational training	177	313.33
	Bachelor's degree	173	274.46
	Post graduate degree	188	298.67
	None of the above	10	332.60
	Total	588	
economical	Secondary school (college)	40	267.40
	Trade/technical/vocational training	177	253.34
	Bachelor's degree	173	328.24
	Post graduate degree	188	308.18
	None of the above	10	290.50
	Total	588	
social	Secondary school (college)	40	351.60
	Trade/technical/vocational training	177	327.36
	Bachelor's degree	173	278.18
	Post graduate degree	188	267.51
	None of the above	10	274.40
	Total	588	

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of environmental is the same across categories of income.	Independent-Samples Kruskal-Wallis Test	.103	Retain the null hypothesis.
2	The distribution of economical is the same across categories of income.	Independent-Samples Kruskal-Wallis Test	.290	Retain the null hypothesis.
3	The distribution of social is the same across categories of income.	Independent-Samples Kruskal-Wallis Test	.182	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of environmental is the same across categories of size.	Independent-Samples Kruskal-Wallis Test	.785	Retain the null hypothesis.
2	The distribution of economical is the same across categories of size.	Independent-Samples Kruskal-Wallis Test	.412	Retain the null hypothesis.
3	The distribution of social is the same across categories of size.	Independent-Samples Kruskal-Wallis Test	.517	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of environmental is the same across categories of owner.	Independent-Samples Kruskal-Wallis Test	.502	Retain the null hypothesis.
2	The distribution of economical is the same across categories of owner.	Independent-Samples Kruskal-Wallis Test	.407	Retain the null hypothesis.
3	The distribution of social is the same across categories of owner.	Independent-Samples Kruskal-Wallis Test	.513	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Promoting environmentally friendly activities

activities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	397	59.6	65.4	65.4
	No	210	31.5	34.6	100.0
	Total	607	91.1	100.0	
Missing	System	59	8.9		
Total		666	100.0		

act1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	fundraising	51	7.7	100.0	100.0
Missing	System	615	92.3		
Total		666	100.0		

act2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Creating a network	76	11.4	100.0	100.0
Missing	System	590	88.6		
Total		666	100.0		

act3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Social movement	103	15.5	100.0	100.0
Missing	System	563	84.5		
Total		666	100.0		

act4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Assessing the environmental impacts	155	23.3	100.0	100.0
Missing	System	511	76.7		
Total		666	100.0		

act5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective voice	91	13.7	100.0	100.0
Missing	System	575	86.3		
Total		666	100.0		

Regulations and certification**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
reg	596	1	5	2.77	1.008
reg2	596	1	5	2.70	1.194
cert	596	1	5	2.63	.905
mat cert	596	1	5	2.60	.884
Valid N (listwise)	596				

	manufacturer	builder	architect	environmentalist	regulator	consumer
disagree (enough regulation)	31.9%	33.6%	42.3%	40.0%	31.8%	24.8%
neither agree nor disagree	47.3%	46.3%	40.8%	53.3%	52.3%	54.4%
agree (enough regulation)	20.9%	20.1%	16.9%	6.7%	15.9%	20.8%

disagree (knowledge of regulations)	42.9%	33.6%	46.5%	51.1%	45.5%	54.4%
neither agree nor disagree	24.2%	33.6%	16.9%	37.8%	22.7%	30.4%
agree (knowledge of regulations)	33.0%	32.9%	36.6%	11.1%	31.8%	15.2%

disagree (enough building certificates)	36.3%	38.9%	49.3%	28.9%	34.1%	23.2%
neither agree nor disagree	49.5%	47.7%	45.1%	68.9%	59.1%	64.8%
agree (enough building certificates)	14.3%	13.4%	5.6%	2.2%	6.8%	12.0%

disagree (enough building material certificates)	33.0%	44.3%	52.8%	28.9%	31.8%	23.2%
neither agree nor disagree	52.7%	43.6%	40.8%	66.7%	59.1%	65.6%
agree (enough building material certificates)	14.3%	12.1%	6.3%	4.4%	9.1%	11.2%

Influential factors on green purchase behavior

	increasing concern	availability of materials	accessibility of information	communication with consumer	pollution of building construction
manufacturer	3.9	2.7	2.4	3.3	2.8
builder	3.7	2.5	2.3	3.1	3.1
architect	3.7	2.6	2.1	3.1	3.3
environmentalist	3.5	2.4	2.1	3.1	3.2
regulator	3.6	2.5	1.9	3.2	3.0
consumer	3.9	2.8	2.6	3.3	2.8

Material specifications

	health	durability	cost	performance	impacts	safety
manufacturer/ supplier	286.32	241.54	262.92	237.66	313.84	287.55
builder	267.77	252.01	245.39	277.40	297.79	278.98
architect/ designer	296.23	259.12	287.85	249.43	260.16	285.76
environmentalist	226.56	344.85	334.51	342.02	189.17	242.52
regulator	260.41	335.73	292.45	260.27	216.38	252.54
consumer	259.57	285.22	263.81	296.32	271.63	253.28

Roles and responsibilities

	enhancing	attitude	implementing	checking	ideas
consumer	31.2	23.7	15.5	2.1	8.0
manufacturers/ suppliers	22.5	12.0	11.0	16.8	13.4
architects	14.5	18.7	31.2	7.0	51.7
regulators	22.5	28.6	28.4	62.1	12.7
environmentals	1.2	10.3	1.2	1.2	4.9
builders	8.0	6.6	12.6	10.8	9.2

Appendix 7

12 item NEP scale

1. We are approaching the limit of the number of people that the Earth can support.
2. The balance of nature is very delicate and easily upset.
3. Humans have the right to modify the natural environment to suit their own needs.
4. Humankind was created to rule over the rest of nature.
5. When humans interfere with nature, it often produces disastrous consequences.
6. Plants and animals exist primarily to be used by humans.
7. To maintain a healthy environment, we will have to develop a “steady state” economy where industrial growth is controlled.
8. Humans must live in harmony with nature in order to survive.
9. The Earth is like a spaceship with only limited room and resources.
10. Humans don’t need to adapt to the natural environment, because they can remake it to suit their needs.
11. There are limits to growth beyond which our industrialized society cannot expand.

12. Humankind is severely abusing the environment.

Focus group rules

- *The information shared in this meeting is confidential. You should not discuss the opinions and comments made by other focus group participants with anybody outside this room. We would like you and others to feel comfortable when sharing information.*
- *You do not need to agree with others, but you should listen respectfully as others share their views.*
- *We would like to hear a wide range of opinions: please speak up on whether you agree or disagree.*
- *There are no right or wrong answers, every person's experiences and opinions are important.*
- *The meeting is audio recorded, therefore, please one person speak at a time.*
- *Please turn off your phones.*

Appendix 9

The role of architects in increasing the use of reclaimed and recycled building materials in New Zealand

INFORMATION SHEET FOR PARTICIPANTS of Focus Groups

You are invited to take part in this research. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to participate, thank you for considering this request.

Who am I?

My name is Zahra Balador and I am a Doctoral student in Architecture at Victoria University of Wellington. This research project is work towards my thesis.

What is the aim of the project?

This project will investigate the role of architects, as decision-makers, in selecting recycled building materials in the process of building construction, comparing to other stakeholders in the recycled building materials market. The ambiguity in perceptions of stakeholders about their roles, expectations, interrelations, and demands will be explored and documented. The research will aim to identify the most influential stakeholder(s) able to increase the future use of recycled building materials, and any constraints on them.

This research has been approved by the Victoria University of Wellington Human Ethics Committee 26502.

How can you help?

You have been invited to participate because you are one of the stakeholders who has some influence on this market, and based on the results of the survey questionnaire your group is one of the most influential stakeholders for this study (the most influential stakeholder groups are architects or designers, consumers and regulators). If you agree to take part you will be part of a focus group in Victoria University. I will ask you and other participants, questions about your attitudes and perceptions about reclaimed and recycled building materials and the opportunities and barrier of future increase of use. The focus group will take 1 to 2 hours. I will audio record the focus group with your permission and write it up later.

The information shared during the focus group is confidential. That means after the focus group, you may not communicate to anyone, including family members and close friends, any details about the focus group.

You can withdraw from the focus group at any time before the focus group begins.

You can also withdraw while the focus group is in progress. However it will not be possible to withdraw the information you have provided up to that point as it will be part of a discussion with other participants.

What will happen to the information you give?

This research is confidential. This means that the researcher named below will be aware of your identity but the research data will be combined and your identity will not be revealed in any reports, presentations, or public documentation.

Only my supervisors and I will read the notes or transcript of the focus group. The focus group transcripts, summaries and any recordings will be kept securely and destroyed on 1/1/2021.

What will the project produce?

The information from my research will be used in my PhD dissertation and academic publications and conferences.

If you accept this invitation, what are your rights as a research participant?

You do not have to accept this invitation if you don't want to. If you do decide to participate, you have the right to:

- choose not to answer any question;
- ask for the recorder to be turned off at any time during the focus group;
- withdraw from the focus group while it is taking part however it will not be possible to withdraw the information you have provided up to that point;
- ask any questions about the study at any time;
- read over and comment on a written summary of the focus group;
- be able to read any reports of this research by emailing the researcher to request a copy.

If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact:

Student:

Name: Zahra Balador

University email address:
Zahra.balador@vuw.ac.nz

Supervisor:

Name: Morten Gjerde

Role: Supervisor

School: Architecture and Design

Phone: 4636233

Morten.gjerde@vuw.ac.nz

Name: Nigel Isaacs

Role: Supervisor

School: Architecture and Design

Phone: 4639745

Human Ethics Committee information

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Dr Judith Loveridge. Email hec@vuw.ac.nz or telephone +64-4-463 6028.

The role of architects in increasing the use of reclaimed and recycled building materials in New Zealand
CONSENT TO PARTICIPATE IN FOCUS GROUP

This consent form will be held for 3 years until 1/1/2021.

Researcher: Zahra Balador, School of Architecture and Design, Victoria University of Wellington.

- I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time.
- I agree to take part in an audio recorded focus group.

I understand that:

- I acknowledge that I am agreeing to keep the information shared during the focus group confidential. I am aware that after the focus group, I must not communicate to anyone, including family members and close friends, any details about the focus group.
- I can withdraw from the focus group while it is in progress however it will not be possible to withdraw the information I have provided up to that point as it will be part of a discussion with other participants.
- The identifiable information I have provided will be destroyed on 1/1/2021, in one year after finishing the thesis.
- Any information I provide will be kept confidential to the researcher and the supervisor.
- I understand that the results will be used for a PhD dissertation and academic publications and/or presented to conferences.
- My name will not be used in reports, nor will any information that would identify me.

Yes ☐ No ☐

Yes ☐ No ☐

Yes ☐ No ☐

- I would like a summary of the focus group:
- I would like to receive a copy of the final report and have added my email address below.

Signature of participant: _____

Name of participant: _____

Date: _____

Contact details: _____