A Demonstration Sustainable Building:

A tool for investigating environmental values

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Abstract

This study explores the engagement of groups from tertiary education and the community in the refurbishment of an existing log cabin structure to function as a demonstration facility for exhibiting sustainable building and living practices to the community. The research focuses on educating the public about sustainable building and living practices and, as a result, inspiring pro-environmental behaviour. The central question is why people choose to engage with the various stages of creating a sustainable building and their attitudes towards behaving sustainably. The research approach is explorative, mainly making use of qualitative methods. It is a case study of creating, monitoring, and using a sustainable building including a series of pre and post-engagement structured discussions and interviews with those involved. Thematic analysis is used to identify patterns and themes within the qualitative data, and quantitative methods are used in analysing data from surveys. This study argues for the potential of a demonstration project to change the values of people through active, systematic, and successive learning, both in the building and the visiting phases. The key findings show that people's involvement increased as the project gained momentum. When the building was almost half finished people began to volunteer to take part in the project. The acceptance tipping point came when the project was sufficiently advanced that people could see becoming involved would produce something tangible. The results suggest that changing to sustainability stems from the initial involvement of a few highly motivated individuals but when there is sufficient physical reality and reduced psychological distance, more people became involved.

Keywords: *sustainable buildings, demonstration project, psychological distance, tipping point, pro-environmental behaviour, social and cultural sustainability, retrofitting.*

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List of Abbreviations

AC	Adverse Consequences
ALF	Annual Loss Factor
B	Builder
BPI	Building Performance Index
BRANZ	Building Research Association of New Zealand
BRE	Building Research Establishment (UK)
BREEAM	Building Research Establishment Environmental Association Methodology
CEPHEUS	Cost Effective Passive House as European Standards
CSH	Code of Sustainable Homes (UK)
EC	Environmental Concerns
EIT	Eastern Institute of Technology
EPBD	Energy Performance of Building Directive
EROI	Energy Return on Investment
GGH	Gemco Group Holdings
HHP	Hockerton Housing Project
IEA	International Energy Agency
kWe	Kilowatt electrical
kWh	Kilowatt hour
ITM	Independent Timber Merchants
LC	Log Cabin
LCA	Life-cycle analysis
LC-ZEB	Life-cycle zero energy buildings
LCP	Log Cabin Project
LEED	Leadership in Energy and Environmental Design
LtG	Limits to Growth
NAT	Norm-activation Theory
NEP	New Environmental Paradigm
Net ZEB	Net-zero energy building
nZEB	Nearly zero energy building
NZGBC	New Zealand Green Building Council
PH	Passivhaus (English: <i>Passive house</i>)
PHI	Passivhaus Institute
PV	Photovoltaic
SCMT	The EU Working Group Sustainable Construction Methods & Techniques
SD	Student designer
SDC	Sustainable Development Commission
SGD	Student graphic designer
SP	Sponsor
SS	Strong sustainability
Std dev	Standard Deviation
TPB	Theory of Planned Behaviour
UNEP	United Nations Environment Programme
VAD	Visual Arts and Design
VBN	Value-belief-norm
VOC	Volatile organic compound
WCED	World Commission on Environment
WS	Weak sustainability
ZEB	Zero energy building

Chapter 1: Introduction

“I regard our buildings as opportunities to embark on specific investigatory processes.”

Thomas Herzog (Ingeborg et al., 2002)

This thesis discusses the engagement of groups from tertiary education, the community, and the building industry in the refurbishment of an existing log cabin to function as a demonstration sustainable project. The project set out with the aim of educating the public about sustainable building and living practices and, as a result, inspiring pro-environmental behaviour. Accordingly, the thesis describes the development of a research process that would uncover the complex factors behind behavioural influences. The research investigation is a case study of creating, monitoring, and using a sustainable building to analyse why participants become engaged with the project, and as a consequence how their behaviour might change towards sustainability.

1.1 The research context

Essentially, the thesis is a contribution to understanding people’s increased knowledge of and concerns for environmental issues related to living in a built environment (Schultz, 2001; Dunlap et al., 2000), and how demonstration building projects can help support further awareness of ecological practices. It focuses on gathering experiences from the process of designing and constructing a demonstration sustainable building and analysing these to find the motivation behind the involvement in the project of different people, and to see how their engagement may have changed as the project progressed. In addition, the research looks at *buildings that teach* by way of design interventions through displaying environmental practices and solutions as *good examples* in order to

inform choices, to demonstrate practices that are sustainable, and inspire behavioural change through how the building is designed and used. It also aims to realise the possible effects of being part of such a process on those involved in the project and to investigate whether their practical participation will steer their future choices.

1.1.1 Environmental limits

As a background, 40 years after a team of analysts from the Massachusetts Institute of Technology published the controversial *Limits to Growth* in 1972 (Meadows et al., 1972), a comparison of historically collated data compared favourably with the key predictions that came out of the MIT team's simulations. These include comparisons of the sub-systems of: population, food production, industrial production, pollution, and consumption of non-renewable sources. The data comparison gave support to the original conclusions that in 40 years growth in both human population and the material economy have caused changes in these sub-systems at greater speeds than ever before in the history of humankind (Meadows et al., 2004, pp. 24–36; Turner, 2012; Randers, 2012a; Vale & Vale, 2009). Physical growth, being the dominant strategy of the world's socioeconomic system for more than two hundred years, and the policies that come from it, are putting considerable pressure on the resources and infrastructure of a finite planet (Meadows et al., 2004, pp. 24–36; Adams, 2009, pp. 133–138). The effects are increases in the human ecological footprint, the area of land of average global productivity that is needed to produce a service or good on a sustainable basis (Rees & Wackernagel, 1995). This will result in humanity placing a huge burden on global ecosystems. Consequently, there is a need for a *strategy* to support sustainable practices and ecological awareness in all sectors of human society, including the built environment. Consequently this thesis explores the importance of demonstration projects for sustainable building as a tool for promoting change in the immediate community and supporting a process of moving towards a sustainable environment in terms of both building and living. This includes the environmental impacts of buildings and their

operation such as material resource use, energy use, water use, and waste generation and how design can help to minimise these (Figure 1.1).

Figure 1.1 Natural sandstone, Stockton Mine, Buller. New Zealand industries and organisations will need a licence to operate within environmental limits. Photo: Jo Cavanagh.

Source: Development within environmental limits, 2017. Retrieved from:

<http://www.landcareresearch.co.nz/about/sustainability/annual-reports/annual-report-2015/environmental-limits>

The built environment has already been singled out as a key area of concern for sustainable and social development in an international perspective (CIB, 1999; SCMT, 2003). Consequently, building activities and the built environment must be considered as being in need of change. Therefore, encouraging the public to adopt sustainable criteria and practices in relation to building activities and the built environment is essential. Consequently, the relevancy of this research emanates from the importance of getting the public to realise the effects of the stress placed by humanity on the global environment and their part in this (Meadows et al., 2004, p. 24; Vale & Vale, 2009, p.9). This is done by looking at ecological building techniques and practices. The research also endeavours to demonstrate, through a building project, methods and choices by which the public can be educated about how to live and build sustainably.

1.1.2 Demonstration buildings

The use of a demonstration facility has been advocated as an effective tool to bring about change in consumer and community choices, and construction practices (SCMT, 2004; IEA SCH Task 40, 2012). In Europe, considerable efforts have been made to support and promote the use of demonstration projects for sustainable building to develop a culture of environmental performance as a

way of verifying improvement, including criteria for achieving various aspects of sustainability (DTI & BRE, 2009; DTI, 1998; The Swedish Environment Protection Agency, 2003).

There are *good examples* of sustainable buildings in a number of countries that were designed to showcase sustainable building practices and promote pro-environmental behaviour (Dietz et al., 2009; Daly, 2008; Kua & Lee, 2002). The experience from such a demonstration project could have an *internal* influence on those involved in its design, building and execution as well as an *external* influence on the parties and communities outside that project group that come into contact with it, both during its building and afterwards. The internal and external influences will be dependent on the transmission of experiences within the project group, as well as the transmission of these to other interested parties outside it. Additionally, the techniques and methods incorporated within a demonstration building have to have relevance for the building types found in the local community.

1.2 The aims and scope of this research

This research sets out to contribute to an increased understanding of the issues that human beings face in relation to the living environment, resource availability, and ecological problems. It attempts to understand how engaging in the process of designing and refurbishing an existing building to become a demonstration sustainable facility may influence the behaviour of the different individuals involved towards further pro-environmental actions.

1.2.1 Sustainable buildings

The concept of sustainable buildings is still rather new to those in the building sector, and remains largely unknown to the public in general. The environmentalist and author Richard Heinberg described the essence of the term sustainable as ‘holistic’ and characterizes it as something that can be maintained over time (Heinberg, 2010, p.1). This implies that unsustainable societies cannot continue to function for long and will come to an end at some point (Heinberg,

2010, p.1). Atkinson et al. (1997, p.3) defined sustainable development as, “development that lasts.” On the other hand, Herman Daly (2002) recognized that, “sustainable cannot mean forever...[sustainability] is a way of asserting the value of longevity and intergenerational justice, while recognizing mortality and finitude.” Therefore, sustainability is a relative term and in order for a sustainable goal to be defined and be functional, it has to be time bound in acknowledgment of its limits and mortality. This has implications for the design of sustainable buildings since buildings have a life-cycle, so are to an extent time limited. However, complications arise as it is not the buildings that are sustainable but rather the people who use them, so that the design of the building needs to acknowledge the limits within which its users will operate. Nowadays, however, the term ‘sustainable’ has become widely used to refer merely to practices that are supposed to be more environmentally sound than others without these deeper user considerations (Heinberg, 2010, p.2). However, sustainable building also involves other important factors of social, economic, and cultural character. These are often expressed through consideration given to indoor climate, health, comfort, etc. at the individual level and economic (sustainable) development and sharing of resources at collective and community level (Dietz et al., 2009; Heschong, 1979; Pretty, 2011).

Subsequently, it is important to define the term *sustainable building* as it applies to this particular research project. As stated above, in New Zealand neither the building industry nor many members of the public are very familiar with the concept. There are other terms used by the building sector such as *ecological* or *environmental* building that are seen as parallel with the term sustainable building. For this research, a sustainable building is described as *one that adopts processes that are environmentally responsible, is resource-efficient throughout its life-cycle, is part of a living habitat and culture, and recognizes that there are limits to the resources available.*

1.2.2 Pro-environmental behaviour

Given the importance of developing individuals who behave responsibly towards the environment, it is critical to raise awareness of and actively promote

community environmental education as a tool for encouraging responsible citizenship behaviour (Hines et al, 1986/ 87; Hungerford & Volk, 1990). Having said that, environmental education, being issue related, must focus beyond environmental sensitivity and issue awareness. If environmental issues are to become part of instructions designed to change behaviour, these instructions must be given the opportunity to develop the sense of *ownership* and *empowerment* so that individuals are prompted to become responsible and active citizens (Hungerford & Volk, 1990). Therefore, it is important to emphasise that this thesis is not just about creating a sustainable building; it is about using the process of designing and building to investigate the values held by the people who do and do not elect to become involved in the process. Hence, the research moves beyond creating a sustainable building and attempts to understand and analyse the influences that motivate individuals to be pro-environmental.

Considering the capacity of demonstration projects to act as educational tools and to initiate shifts in people's values towards sustainability (SCMT, 2004; The Swedish Environment Protection Agency), the research needs to probe the potential of the building for fostering pro-environmental behaviour in the various actors in the sectors of education, the building industry, and the wider community. These people will engage with the project in its different stages, including those of designing, sponsorship, building, management, promotion and visiting.

1.2.3 Design for behavioural change

Architects and designers have been practically involved in influencing people's behaviour through the planning and design of human environments, nonetheless behaviour intervention studies are not yet common within design research, with such studies more established in social and environmental psychology and allied fields (Abrahamse & Steg, 2013; Lockton et al., 2013). In general, this research project is about introducing a number of interventions for behaviour change through exhibiting sustainable building practices as exemplars for the community. These are *educational* interventions aiming at encouraging people to

behave more sustainably; *technical* interventions with the general objective of encouraging people to adopt more sustainable technologies and so reducing human impact on earth; and *social* interventions to create a shift towards sustainable communities initiated by engaging in a sustainable project and showing possible new ways of behaving.

1.2.4 Existing buildings and sustainable development

Given that the slow rate of new building accretion compared to the existing stock refitting an existing building is significant for sustainable development because of the potential for major gains in energy efficiency and waste reduction. As a strategy for sustainable development, it is essential to introduce techniques and practices to extend the life of existing structures, as physical assets, and to prolong the utilisation of materials with which they were originally constructed (SDC, 2006; SCMT, 2004). Hence, the research highlights the importance of upgrading the performance of existing buildings and their surroundings as an efficient utilisation of resources given their relatively poor sustainability credentials compared to those of new buildings (Klunder, 2005; van Bueren & de Jong, 2007).

Another reason for considering existing buildings is the large portion of extracted materials stored in the built environment making it potentially a significant source of secondary materials or an enormous source of waste (Kibert et al., 2002). Nicklaus Kohler (1999) stated that, “the objective of sustainability is not to improve the building stock qualitatively, but ...to develop techniques to maintain, refurbish, and adapt new technologies to fit the existing buildings to new requirements and to adopt new technologies to fit the existing buildings.” So, if old buildings are embedded with integrated techniques in such a way as to satisfy certain criteria for economic and ecological sustainability, a combination of building conservation and environmentally responsible techniques can contribute toward sustainability in the built environment.

1.3 Research Objectives and Question

From an architectural perspective, a starting point for this thesis was to gather and analyse experiences from a wide variety of sources of information about sustainable building practices in order to come up with criteria from which to design and build a sustainable project as an inspiring example. Through this dialogue, two objectives were formulated, *how to determine* sustainable practices for this particular building and *how to present* an example of a sustainable building in order to provide useful information for the public, reflective of concepts of sustainable building and living practices. From an environmental psychology perspective, the research is an experiment to examine the potential for influencing pro-environmental behaviour in those associated with it at the different stages of the building process, including an investigation of the values they hold. The investigation will explore the motivations of individuals and various groups who choose to become involved in the project.

According to Kollmuss and Agyeman (2002), pro-environmental behaviour simply means, “behaviour that consciously seeks to minimise the negative impact of one’s actions on the natural and built world.” To achieve this entails initiating shifts in people’s attitudes towards sustainability. So, what determines an individual’s pro-environmental behaviour? To find out, a series of focus group interviews and surveys were carried out with the actors associated with the project at its different stages; designers, sponsors, trades people, administrators, and visitors. From this, three research questions have been formulated:

1. *Why do people choose to engage with the various stages of a demonstration project for sustainable building,*
2. *How does this engagement relate to the individual’s environmental behaviour and values, and*
3. *Will this engagement lead to further adoption of sustainable practices?*

1.4 The Log Cabin

The building in question is an existing Log Cabin (LC) at Otatara Hills in Hawke's Bay, on a site that is part of the Eastern Institute of Technology (EIT) (Figures 1.2, 1.3). The development of the project includes maintaining and refurbishing the existing Log Cabin to become a demonstration facility for showcasing sustainable building design and construction technologies as an educational tool and focus for the behaviour and values that support sustainability. On another note, the fact that it is a log construction, which is not typical in New Zealand, means there is nothing people can copy directly, which suits the aim of the project as being educational, thus focusing on the exhibited refitting techniques.

(a) (b)
Figure 1.2 Views of the Log Cabin, (a) from the northwest, (b) from the south.
Source: Alan Neilson photos, 1997.

1.4.1 The location

The Otatara site in Hawke's Bay, New Zealand, is an example of a place that has strong historic, cultural, and spiritual associations with local Māori (Pishief, 1997). Otatara Pa, which covers over 40 hectares, is one of the largest and oldest Māori villages in Hawke's Bay. It was favoured by the local Māori tribes for its strategic location, expansive views, and access to a range of natural resources, thus for the Māori was a sustainable place, long before the recent popularization of the concept. Otatara is also linked through *Whakapapa* (Māori genealogy) to people and places throughout New Zealand (Pishief, 1997). In the late 1970s, an arts programme was established up at the Otatara Homestead Site (part of Otatara

Hills) in an attempt to connect modern knowledge with traditional knowledge and wisdom to produce better outcomes for the community in terms of both education and culture (Harré, 2012 August 18). This project thus aims to continue this ideal.

Figure 1.3 The Log Cabin location, Eastern Institute of Technology Campus, Napier, New Zealand

1.4.2 The building

The LC is square in plan with an internal footprint measuring 6x6 metres with a small lean-to accessed through a door in the centre of the eastern wall and a mezzanine level accessed from a stair against the north wall (Figure 1.4). It has a concrete floor and a timber roof structure with an overhang to protect the log walls. The building is connected to the electricity grid and mains water supply. The small size of the building was seen as an advantage as it meant that its development would be centred on a confined indoor area, thus reducing the capital and sponsorship needs.

The Log Cabin Project (LCP), part of a bigger sustainable development plan on the Otatara homestead site, was strongly supported by EIT Hawke's Bay and also by the local Māori community of Waiohiki because it was intended to be an educational tool to promote behaviour and values that support sustainability. Being an institution for learning and a significant part of the community, EIT is

the appropriate place to locate this kind of building project because, as an organisation, it deals with attitudes and values, which is what education is about.

Figure 1.4 Ground Floor Plan of the Log Cabin before improvements.

Although a building of solid log walls might not seem an ideal starting point from which to make a sustainable building, without refurbishment this unoccupied building would have continued to deteriorate and might well have been demolished. The problem was to find ways to minimise the environmental impact of this building once converted that would be both appropriate and affordable.

1.4.3 Revisiting what has been established

In 1975, the Eastern Institute of Technology (EIT) was opened as the Hawke's Bay Community College. It was the first in a number of similar institutions subsequently established in other parts of New Zealand (Eastern Institute of Technology, 2011). According to John Harré, the institution's first Principal (1975–1986);

“The place was set up as a community oriented organisation for education...It was to try to create an environment where people in the community felt comfortable in telling us (the institution) what they felt they needed in post-school education...As a result, there were a whole

raft of activities that began at the institution where the core ones were related to vocational training, trade, and so on.” (Harré, 2012 August 18).

As part of that process, there were elements that were considered important at that stage related to recognising the needs of the indigenous Māori community, particularly creative activities such as music, writing, and arts. Hawke’s Bay Community College regarded creative and artistic work as vocations and core elements in developing people’s personalities and confidence. As a result, programmes such as the arts, writing, and women’s studies were seen as ways of creating opportunities for people to move from where they were into something constructive (Harré, 2012 August 18).

In this context, the Otatara Arts Centre programme, as it was known then, was established up on Otatara Homestead Site (Figure 1.5) after the original Art Room was no longer big enough to accommodate the programme. When student numbers and facility needs grew, a call for new spaces arose. The approach to sourcing new facilities was that of recycling-reuse, so additions were established either as new constructions utilising mainly recycled materials or as existing buildings, most of which had passed their prime, which were relocated to the site and refitted. This approach had an influence on the attitudes of the students in the programme in terms of learning ways of utilising available resources, an essential attribute of being sustainable.

Ray Thorburn, who was the Curriculum Development Officer at the Ministry of Education at that time, explained;

“The whole philosophy behind Otatara and the arts programme is that it was built around people, it was not about *numerical* standards. The standards in fact have been there in terms of visual and artistic qualities, belief in people, and moving people from one level of experience to another. What happened there had to belong to the people and had to be appropriate for that particular environment and context” (Thorburn, 2012 August 18).

Figure 1.5 Otagata Arts Centre, Jacob Scott drawing, 1985. The Log Cabin is marked by the red circle on the right.

The building of the Log Cabin was completed in 1986 as a community initiative to learn log-building techniques and was later finished off by the Otagata Arts Centre under a government scheme called Project Employment Programmes (PEP). The building scheme involved contributions from expert builders from Canada who were specialised in that type of construction and who hoped to promote log-building methods in New Zealand. Eventually, the log cabin was used as a staff office space and later as a teaching studio space and an artist-in-residence living space. Although the arts programme moved away from the hill site in the early 1990s, the cultural and social associations with the programme are still there. The log cabin is now the only building left standing from the original Otagata set up after all the other buildings were deemed unfit as teaching facilities, because the cost of maintaining them there was considered unfeasible. So a decision was made to relocate them at Waiohiki (the nearby area of which Otagata Hills is a part), and with them went the Wairua (spirit) of the place, according to Māori beliefs. Although the Visual Arts and Design (VAD) programme's buildings have been shifted away from that site, the cultural and social associations with the programme are still there. These will provide the continuum for a 'living pattern' when the demonstration project is launched.

1.5 Thesis content and structure

This thesis consists of three parts. The first part comprising Chapters 2 – 4 provides the background and review of relevant literature. *Chapter 1* introduces the research context, research aims and questions, together with details of the log cabin and its location. *Chapter 2* presents concepts of sustainability and sustainable building as well as discussing contemporary ecological problems and environmental limits. It defines what a sustainable building means in this research. In addition, it discusses the social and cultural dimensions of sustainable buildings. *Chapter 3* is a review of the relationships between people and sustainability. It first presents literature on environmental attitudes, ecological behaviour, and environmental education. It looks at theories and practices that explain human behaviour with particular focus on pro-environmental behaviour. Secondly, it discusses concepts of ‘design processes for behaviour change’ examining examples from the UK and US in the fields of design and architecture. It also looks at demonstration projects for sustainable building. *Chapter 4* provides an overview of some common sustainability rating systems; BREEAM, LEED, and Green Star. It discusses the German Passivhaus criteria and goes on to look at the criteria for the different types of zero energy buildings.

The second part comprising Chapters 5 – 6, presents the research approach and methods, and the empirical studies. In *Chapter 5* the gap in knowledge is identified and the overall research approach and research design is set out. The two main research tools of focus groups/interviews and surveys are introduced. The research plan is also presented. *Chapter 6* discusses how the building project was set up to become a demonstration facility for behaviour change. This consists of three separate sets of empirical studies based on the project process stages of design, building, and demonstration. The chapter discusses the process of developing sustainable design criteria and the involvement of students in the project brief development and concept design. A similar process is discussed regarding the graphic design concepts of the project. Ways of raising funds through sponsorship are described. The chapter further explains the role of visitors to the project in the research

The third part comprising Chapters 7 – 9 deals with data analysis, discussions, comparisons, and conclusions. *Chapter 7* presents the results of the thematic analysis of the actors associated with the project at the three stages of design, building and demonstration. A series of pre and post-engagement interviews and focus group discussions are described as well as visitor's surveys undertaken pre and post-visit. *Chapter 8* discusses the level of involvement of people who worked on or visited the project and whether this had any visible effect on their environmental values. It makes comparisons between types of people involved. Findings from this analysis suggest that motivation to engage in a demonstration sustainable project increases after a tipping point, which coincides with a perceived reduction of psychological distance. Finally, *Chapter 9* returns to the research questions and answers these. It also discusses the addition to knowledge. It further discusses the limitations of the research and ends with a proposal for continued work in the field.

1.6 Summary

This chapter set out to show how going beyond the earth's limits to supply the resources needed to maintain the current consumer lifestyle, existing mainstream building processes, and economic growth could lead to tragic consequences (Meadows et al., 2004). Therefore, there is a need to educate the population about sustainable living practices and steer their attitudes towards pro-environmental behaviour. This has led to two major questions: Can a sustainable building help in this process through influencing the behaviour of those involved with it? And can the project serve as a catalyst for behavioural change for the actors involved in the project?

All design affects behaviour, whether this is intended or not. Hence, this research aims to see whether behaviour can be influenced through some form of contact with a demonstration sustainable building. The research involves an existing log cabin located at the Otatara Hills site in Hawke's Bay, which has deep historical, cultural, and spiritual connections with indigenous Māori of New Zealand. Given

this, the concept for the project refurbishment respects and contributes to preserving natural ecosystems and cultural capital.

The next chapter will outline critical relevant concepts of sustainability including; what a *sustainable building* actually means in this research, the significance of refurbishment, the importance of considering environmental limits, and the social and cultural dimensions of sustainability.

Chapter 2: Sustainability and sustainable buildings

“Earth has become a space ship, not only in our imagination but also in the hard realities of the social, biological, and physical systems in which man is enmeshed”.

Kenneth Boulding (Earth as a space ship, 1965, p.2).

In our finite planetary system, sustainability could be described as a situation where the demands placed on the environment are met without decreasing the planet’s capacity to allow people to live well, now and in the future (Meadows et al., 1972, pp156–158). Consequently, sustainable building needs to be a process of helping the construction industry meet building demands, reduce impact on planetary resources, and contribute to an ecologically sound environment, for present and future generations.

2.1 Contemporary ecological problems

The state of the world at the beginning of the 21st century could be drawn as a picture of unsustainable development characterised by exponential population growth, material based economies leading to increasing consumption, together with an unequal distribution of resources (Meadows et al, 2004, pp. 24–36; UN-HABITAT, 2006). Modern economic activities and the push for economic growth have resulted in consequences that have ecologically affected the planet, mainly in the high recorded levels of carbon dioxide and resultant climate change, a proven scientific fact that, “will transform patterns of human settlements and undermine the viability of national economies” (UNDP, 2007, pp.2–3). Other environmental problems include the extinction of particular animal species (Europa, press release, 22 May 2007), threats to fishery stocks

(UNEP, press release, 19 Oct 2006), premature human deaths due to air pollution, mainly in developing countries (WHO, press release, 5 Oct 2006), and the decline of vital pollinators jeopardizing crops and ecosystems (Gardner & Prough, 2008, pp.3–4). Added to these are predictions that oil production, the world's primary source of energy, will reach its peak by 2022 with insufficient supply expected afterwards (World Energy Council, 2007, p. 44). However, this may be a benefit given that fossil fuels like oil have been implicated in climate change. In relation to health, there is worry over the significant number of synthetic chemicals used commercially worldwide, varying from food preservatives and cleaning detergents to building materials. Although a number of these have been tested and evaluated for their effects on health and the environment, many have never been subjected to thorough tests (Philp, 2013, pp.21–23; Azar et al., 1996, pp.91–92; Petrovic et al., 2017). Furthermore, since the middle of the 20th century, industrial societies face risks resulting from concerns about nuclear power, bio-technological products, as well as ecological threats. Societal choices maybe based on human *decisions*, some with technological and economic advantages, yet in the age of nuclear, chemical, and genetic technology, potentially everyone on the planet could be affected (Beck, 1992).

The 2015 Paris UN Convention on Climate Change recognised climate change as an *urgent* and *irreversible* threat to humanity and the planet, that required the widest possible collaboration, “in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emission” (FCCC, 2015, p.2). Consequently, given the escalation of current environmental problems, carbon emissions need to be stabilised if humanity is to avoid collapse of natural systems. This is a more important priority than human satisfaction, because the latter is dependent on the former.

2.2 Environmental limits and the transition to sustainability

In 1972, a team of analysts published *The Limits to Growth* (LtG), a renowned and controversial book about the results from computer modelling of exponential economic and population growth within finite resource supplies. The team from

Massachusetts Institute of Technology (MIT) had been commissioned by the Club of Rome to analyse the world's problems using a computer 'world model' developed at MIT (Meadows et al., 1972, pp.17–24). The model allowed examination of the interaction of five sub-systems of the global economic system, namely: population, industry, agriculture, natural resources, and the environment (Meadows et al., 1972; Meadows, 2007). LtG was a scenario analysis of twelve possible futures where values to the year 1970 were broadly reproduced in the model, and the time scale continued till 2100 (Randers, 2012a).

The model was established to provide indications of the system's behavioural tendencies as a means of having a better understanding of the behaviour of the global economic system (Meadows et al., 2004, p.x). The scientific conclusion was that delays in global decision making would cause the human economy to *overshoot* environmental limits sometime in the 21st century resulting in collapse in population and the economic system. The collapse could be avoided with a combination of early changes in behaviour, policy, and technology (Turner, 2008; Randers, 2012a; Ehrlich, 2010). Randers, one of the authors of the original LtG study, pointed out that the study addressed the question of how humanity would adapt to the physical limitations of the planet, thus the study predicted that the ongoing growth in human impact on the environment would stop during the first half of the 21st century, and that human use of resources, and associated environmental impact, would be brought down to levels that could be sustained in the long run (2012b).

2.2.1 Four decades after the Limits to Growth

In 2008, Turner carried out a study to compare the LtG scenario outputs of the 1972 global model against 30 years of observed and independent data covering the period from 1970 to 2000 (Turner, 2008). The objective was to distinguish between LtG scenarios in terms of approximate magnitudes and trends in key variables in order to understand the modes of the various global economic and other behaviour systems (Turner, 2008). Out of the LtG's three key scenarios, Turner's study observed that data from 1970 to 2000 most closely matched and

favourably compared with the simulated results of the LtG *standard run* scenario for almost all outputs reported. This represented a business-as-usual scenario and resulted in collapse of the global economy and the environment before the middle of this century (Turner, 2008).

Turner's study also compared historical data with the other two scenarios; *comprehensive technology*, an approach that attempted to solve sustainability issues with a broad range of technological solutions, and *stabilised world*, where both technological and social policies were implemented to achieve equilibrium states for key factors. The comparisons showed that the former was overly optimistic in growth rates of the various factors in the model, while the latter displayed significant departure in the trajectory of key factors (Turner, 2008). It is worth mentioning that at the time of its initial release in 1972, the LtG model was at the cutting edge of computer simulation. Since then, simulation capabilities as well as the availability of data have dramatically increased (Costanza, 2006). In conclusion, the data presented supported the LtG judgment that the global system would be unsustainable unless a rapid and substantial reduction in consumption behaviour, combined with technological progress, occurred.

In 2012, and following his study in 2008, Turner gave an update comparison of LtG with historical data after 40 years, i.e., from 1970 to 2010. Subsequently, the LtG's key scenario *standard run* continued to align well with the historical data updated from his previous comparison (Turner, 2012). The timing of the study almost coincided with the LtG data prediction of the collapse in the global economy, the environment, and subsequently the population after 2030. The general start of the collapse was predicted to appear in 2015, when per capita industrial output was predicted to begin a sharp decline (Turner, 2012).

Based on comparison of observed data and the three LtG scenarios, and given the significantly better alignment with the *standard run* scenario than the other two scenarios (*comprehensive technology* and *stabilised world*), it appears that the global economy and population is on the cusp of collapse (Turner, 2012; Ehrlich, 2010).

The study concluded that the prime cause of collapse in the *standard run* would be resource depletion and the model response of diverting capital away from other sectors such as agricultural, industrial, services (health and education) in order to secure less accessible resources, combined with population growth (Turner, 2012).

Following the justification of the *standard run* scenario, the issue of resource constraints appeared to be a greater and more harmful problem than issues such as climate change and pollution, which according to Turner (2012) were likely to have a much reduced impact if global collapse occurs as per the LtG scenario. This view was supported by Costanza (2006) who highlighted the fact that the forecasts made in 1972 with the aid of a computer model were on target, and that predictions of a collapse under particular scenarios would not start until well past the year 2000. Overall, the true tests of the computer model's predictions will be the coming decades (Turner, 2006).

Human history is full of examples of societies that have either collapsed or succeeded in their attempts to face issues of resource, natural, and cultural threats. The Polynesian settlers in Easter Island are an example of environmental collapse due to the overuse of available resources on the island. The exploitation occurred in isolation from other environmental factors and other societies. By completely deforesting their small island home, the occupants destroyed the ability of the land to support them to the degree that they were eventually unable to build large canoes and sail away (Diamond, 2005, pp.116–120; Costanza, 2006). In contrast, the village of Kampung Naga in West Java in Indonesia is a living example of a community that recognises tradition, culture, and environmental limits. The 102 house settlement preserves the ecological environment through the separation of forest and village areas (Figure 2.1).

Figure 2.1 Kampung Naga, West Java, Indonesia. It is inhabited by a community with strong tradition of holding to cultural customs.

(source: www.lintangbuanatours.com/index.php/kampung-naga.html).

Locals believe that they should protect the sustainable ways of their ancestors, who have lived there for centuries, through managing water, creating a sense of harmony with nature, and adopting locally developed building construction systems. Because the land availability of the village is limited, the population is capped. According to tradition, each house is only occupied by one family, therefore newly married couples have to move out of the village if there are no vacant houses within its boundaries. The residents of Kampung Naga are sensitive to the processes of maintaining the quality of their environment through avoiding waste, using minimal energy, and re-using and recycling (Mouboy, 2007). The impact of the inhabitants has been measured in terms of the ecological footprint (see Section 1.1.1) (Rees and Wakernagel, 1995), being 0.75 gha/person of which 0.70gha/person was the food component (Pamungkas, 2013, p.221).

2.2.2 Criticism of Limits to Growth

Since its introduction in 1972, the LtG study has faced various attempts to discredit its concepts and intentions (Adams, 2009, p.133; Turner, 2012; Bardi, 2011, p.101). According to Bardi (2011) the study was widely misunderstood, misread, and misinterpreted. In particular, the plea for equality was portrayed as

an attempt to destroy the lifestyle of Western societies, while the concepts of stopping activities that can cause pollution and the necessity of slowing down economic growth have generated strong opposition.

Beckerman (1974, p.9, quoted in Adams, 2009, p.133) stated, “a failure to maintain economic growth means continued poverty, deprivation, disease, squalor, degradation, and slavery to soul-destroying toil for countless millions of the world’s population”. However, in a later study, he acknowledged the seriousness of environmental problems when it came to deciding on an optimal policy. He also stressed that the environment would not be managed in a socially optimal manner due to numerous market imperfections, especially concerning the lack of distinct property rights in relation to dealing with global environmental issues such as preservation of biodiversity (Beckerman, 1994). Beckerman and later Summers, President Obama’s chief economist until late 2010, were among many voices in the US maintaining the belief that welfare maximisation should remain an overriding policy objective while taking into consideration inter-generational justice, and that sustainability should not be regarded as a constraint on welfare maximisation unless there was a clear conflict between the two. This, they believed was yet to be demonstrated (Beckerman, 1994; Curry, 2011, p.231; McKibben, 2010, p.47). Daly explained that Beckerman’s views were based on his mistaken definitions of the sustainability concept and that sustainability as a logical constraint “does limit present welfare maximisation and is not defined implicitly in terms of the same welfare maximisation that it is supposed to limit” (1995). Daly insisted that sustainability was neither morally reprehensible nor operationally impractical and that it provided a better way of respecting the rights of future generations (1995).

Understanding the global problems and environmental threats as outlined in the LtG study proved to be an arduous task compounded by the difficulty of implementing the global actions needed to solve them, particularly in dealing with problems such as the management of global resources (Bardi, 2011, p.102). The problem seemed to lie with issues that require widespread changes in

people's behaviour. Certain measures relating to market strategies or having an impact on economic policies were exceedingly problematic as they could damage some sectors of the economy in spite of benefits to a society as a whole (Bardi, 2011, p.103). Therefore, a level of shared vision had to be reached in order to consider such measures as absolutely necessary, bearing in mind that waiting for societal collapse, as envisaged by the LtG scenarios, would be too late to prevent or resolve issues by means of national or international measures. Prins et al. (2010) stated that a positive effort to mitigate the negative effects of the problems outlined by the LtG study would be needed if general global action proved difficult to implement. They felt such an effort might include a policy of small steps pushing for desirable measures that would be flexible and could be progressively adapted to initiate change related to the extent of the problem and public understanding of the situation. Bardi (2011, p.103) endorsed this view. In relation to this research project, the LtG concepts are enshrined within the small steps that might be demonstrated as exemplars in a building project for the purpose of inspiring the local community and aiming to influence responsible environmental behaviour.

2.2.3. Peak oil debate

The effects of the exponential consumption of natural resources ranging from metals to fossil fuels and atmospheric capacity to absorb waste, as outlined by the *standard run* scenario in LtG, stimulated a discussion around how far such consumption could continue into the future (Meadows et al., 1972, p.25; Turner, 2012). In a review of fossil fuel consumption, Brecha (2013, p.664) stated that no single indicator could prove *peak oil* was close, while Murray & King (2012) stressed oil supply has been unable to keep pace with demand. However, a near-term peak in *conventional* oil production should be taken seriously considering the fact that societies are not yet be prepared for the consequences of declining oil production (Brecha, 2013). Furthermore, the lack of transparency in many models of oil resources and production, inconsistency in the definition and usage of liquid fuels, and the range of methods and assumptions used, have hindered comparisons of global oil supply forecasts (Sorrell et al., 2010b; Murray & King,

2012; Turner, 2012). However, it seems delay in the peak of conventional oil production until after 2030 is unlikely (Sorrell et al., 2010a; Sorrell et al., 2010b). Forecasts have continued to suggest peak oil before 2030 is likely with significant risk of a peak before 2020, especially if this is associated with insufficient supply from non-conventional sources defined as energy generated or collected from renewable sources, naturally replaced (such as solar, wind, hydro, and geothermal sources) (Ellabban, et al., 2014), which is considered a very probable scenario (Sorrell et al., 2010a; Murry & King, 2012). Besides, in 2016 the IEA stressed renewable energy capacity worldwide had been growing more rapidly than expected in the previous five years, and this led it to increase its forecast for the following five years ‘significantly’ (Carbon Brief, 9 October 2016).

Hirsch developed a framework for planning mitigation of future world oil shortages arriving at three scenarios; best case scenario where maximum world production is followed by a relatively flat period of production (a plateau) before the onset of a decline; a middling case scenario where world oil production grows to a relatively sharp maximum followed by a monotonic decline; and worst case scenario when a sharp break is worsened by oil exporters withholding stock, leading to rapidly declining world oil production (2008, p.888). He concluded, the mitigation of growing oil shortages would require an intense effort over decades, and it would take a very long time to build a substantial number of substitute liquid fuel production facilities and generators of alternative forms of energy (Hirsch, 2008).

From a broader perspective, as the world’s energy system is primarily based on finite fossil fuel resources and as human society continues to extract this natural reserve, there is a need to generate an increasing amount of energy inputs for each unit of final energy production. In turn this decreases the Energy Return On Investment (EROI), the relevant measure of opportunity cost (Brecha, 2013; Cleveland, 2005; Murray & King, 2012). In addition, many non-conventional resources also require extraction of water, so water availability may begin to set limits on both fossil fuel extraction and production of electricity (Brecha, 2013).

Therefore, it is not the issue of peak oil that should be of greatest concern but that of bringing together the interconnected loops of environmental, economic, and social systems and the energy needed to run these. With regard to LtG, the concept of peak oil was not about the limit of extraction of fossil fuel from the earth, but rather about the pattern of extraction of cheap oil to which modern developed societies have become accustomed.

2.2.4 Weak and strong sustainability

Adams identified several differing and sometimes conflicting versions of ecological sustainability as a benchmark for a sustainable society. Weak sustainability (WS) is characterised as being economistic by allowing for trade-offs, closed, and national. It is distinguished from strong sustainability (SS), which is described as ecological, calling for zero natural capital depreciation, systematic, and international (Adams, 2009, pp. 144–147). Furthermore, WS and SS differ in their assumptions about the substitutability of natural capital (Dietz & Neumayer, 2007). There has been a passionate debate on sustainability between natural and human-made capital where WS supports the belief that these two types of capital are substitutable, while SS generally contests the possibility of the two being interchangeable, seeing them as complementary (Daly, 1995; Dietz & Neumayer, 2007; Ang & van Passel, 2012). Daly stated that the word ‘complementary’ is key to SS, explaining, “If natural and manmade capital were substitutes (weak sustainability) then neither could be a limiting factor. If, however, they are complements (strong sustainability), then the one in short supply is limiting” (Daly, 1995).

In the view of SS, natural and nature-produced services, such as the atmosphere, are non-replaceable, thus natural capital is complementary to human-made capital. This means the products created by people cannot replace the natural capital found in ecosystems. SS also calls for creating a social and economic system less destructive towards nature, and its advocates are generally pessimistic about the possibility of technological progress (Daly, 1994, quoted in Adams, 2009, p.145; Wilson, 2010). On the other hand, WS advocates for the *optimal*

extraction of resources where the losses incurred may be offset through reinvestment, so that the capital stock will not fall over time. Hence from the WS perspective natural capital and human-made capital are generally substitutes for each other. WS assumes that technological progress will be able to offset the environmental damage in moves towards improved human well-being (Ang & van Passel, 2012; Dietz & Neumayer, 2007; Wilson, 2010). Therefore, WS essentially allows for the continuation of current trends of placing growth ahead of environmentally focused development, hence allowing the human community to manipulate resources to meet its demands on the premise that any problems will be resolved through technological development (Monferda et al, 2004). This position is at odds with the LtG paradigm. The future of human well-being will be determined by humanity's success in dealing with the use of resources and the complexities associated with this, given the planetary space constraints and supply limitations.

2.2.5 Natural capital and sustainable development

Capital is usually defined as things people have built or produced that have value. Environmental economists define these as human-made capital. Natural capital, on the other hand, is created by bio-geophysical processes and is defined as the capital stock that yields the flow of materials and services into the future (Ekins et al., 2003). The two different types of natural capital are renewable natural capital, such as harvested yield ecosystems, and nonrenewable natural capital, such as fossil fuel and minerals (Adams, 2009, p.142; Costanza & Daly, 1992).

According to Costanza and Daly (1992), improvement in human welfare can come about either by pushing more material or energy through the economy or by satisfying more human wants and conveniences out of the materials and energy that pass through it. These two processes are fundamentally different in their effect on the environment and should not be combined. They argue it is better to refer to throughput increase as *growth*, and to efficiency increase as *development* (Costanza & Daly, 1992). Beyond a certain point, growth can destroy natural capital as it becomes impoverishing rather than enriching, because it costs

more than it creates (Costanza & Daly, 1992). Economic development implies increasing capital stocks, but the insight of environmental economics suggests the need to account for the stocks of both human-made and natural capital separately. Therefore, any development that increases stocks of human-made capital by the depletion of natural capital of an equivalent value is considered non sustainable. This is commonly the view of strong sustainability (Adams, 2009, p. 142, 143). De Groot et al. (2003) give guidelines by which to determine the *criticality* of natural capital based on two criteria: the importance of natural ecosystems, and the degree of threat based on quantity and quality of the natural areas in question, but argue that when determining the criticality of a natural capital the two criteria should be considered as complementary.

2.2.6 Environmental limits and the social dimension

In terms of public awareness of environmental issues, such as limits and climate change, Eastin et al. (2011) stated that policy discourses on such issues would benefit from focusing efforts on social, economic, and political dimensions rather than the current excessive emphasis on emissions reduction targets.

Accordingly, they argue for changing the focus away from consumption towards sustainable and responsible production and resource usage, noting this can occur through community level action awareness, communication across multiple sectors, or at governmental levels (Eastin et al., 2011).

In addition to economic problems, it is vital to address the social logic of consumerism within modern, developed world society where the emphasis on lifestyle and material goods is deeply associated with contemporary living (Jackson, 2006, p.143; Thorpe, 2010). A supportive community can help people's efforts to live more simply and to flourish within limits, an idea that has led to the emergence of the so called *intentional communities* such as the Simplicity Forum in North America in 2001 and Downshifting Downunder in Australia in 2005. The aim here is to help individuals achieve and honour simple, just, and sustainable ways of life. The Downshifting movement has established allegiance in a number

of developed countries (Jackson, 2006, p.150). A survey on Downshifting in Australia found that 23% of respondents were engaged in some form of downshifting in the five years prior to the study, and 83% felt that Australians are too materialistic, while an earlier study in the US found that 28% had begun to make things simpler in their ways of living and 62% were willing to do so (Jackson, 2006, pp.150, 151). Such findings endorse the objective of this research to be actively engaging the community with environmental practices in order to inspire pro-environmental behaviour.

The main conclusion of LtG was for global society to reduce its environmental impact per unit of consumption in time, in order to avoid global overshoot, a task that would be much easier if human society moved away from its fascination with growth (Randers, 2012a). This suggests humanity ought to organise its ways in a manner that fits with the physical limitations of the planet (Randers, 2012a; Monfreda et al., 2004). In a study of the value of ecosystem services and natural capital stocks, Costanza et al. (1997) stressed, “If significant, irreversible thresholds are passed for irreplaceable ecosystem services, their value may quickly jump to infinity.” Randers also pointed out that poverty, unemployment, and old age insecurity are the three fundamental and legitimate problems that can lead to the global acceptance of growth policies (Randers, 2012a).

2.3 A sustainable building: what does it mean?

2.3.1 Sustainability and sustainable development

The word sustainability is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up). *Sustain* can mean ‘maintain’, ‘support’, or ‘endure’ (sustain, 2009). Hence a sustainable strategy is one that ought to be followed as in the long run it has the capacity to continue indefinitely. Conversely, unsustainable societies that cannot be maintained in the long run will stop functioning at some point (Heinberg, 2010, p.1). According to the Swedish organisation, The Natural Step, a sustainable society is defined by four system conditions. In this definition, nature is *not* subject to systematic increases of: (1) concentrations of substances extracted from the earth’s crust, (2) concentrations of substances produced by society, (3)

degradation by physical means, (4) and people are not subject to conditions that systematically undermine their capacity to meet their needs (The Natural Step, n.d.). Consequently, a sustainable society would be able to maintain itself for many centuries at least, with sustainability being the essence of all long-term planning (Heinberg, 2010, p.1). However, recognising the finitude of global resources, Daly (2002) affirmed that maintaining the entropic physical flow from natural sources through the economy and back to nature's sinks could not be sustained without declining indefinitely.

The term *sustainable* and *sustainability* became common in the 1980s through the media as people were made increasingly aware of growing environmental problems (Bartlett, 1994). This was heightened after 1987, when the Brundtland Report from the United Nations' World Commission of Environment and Development defined *sustainable development* as development that, "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p.41). Consequently, sustainability included striving to deal with development issues, pollution, and poverty problems in the Third World (Adams, 2009, pp.1(1997). 3). This definition proved extremely influential and was widely used, although it has been criticised for failing to mention the unsustainability of using non-renewable sources and for ignoring the problems caused by population growth (Bartlett, 1994).

According to Michael Toman (2006, p.247), the term sustainability has inherent ambiguities. For ecologists, the term implies the preservation and maintenance of ecological systems, while for economists it suggests supporting and improving the standard of living for human beings. Hence, there arises the dichotomy between long-term sustainable planning for the protection of future generations and that of the short-term directed at the well-being and aspirations of the current population.

Because this research is related to building activity in a world of decreasing ecological health and increasing human demands (Meadows et al., 2004, pp. 24–

36; Adams, 2009, pp. 133–138), creating an ecologically sustainable building requires thinking of and dealing with the fundamental issue of how buildings are constructed and how those who design, make, and use them view the world. This will include developing a holistic worldview and then exploring how to reintegrate existing knowledge in order to create a unifying building process and responsible ways of seeing the world. So a key to grasping the idea of ecology is, “the knowledge that all the elements of the system, whether living or non-living are interdependent” (Graham, 2003, pp.3, 4). Arguably, sustainability can include appreciating how one *new* building can affect the whole system.

This research is directly related to the built environment, which has been singled out by governmental and non-governmental organisations as a key sector of concern for sustainable and social development within an international perspective (CIB, 1999; WGSC, 2003, p.11; van Bueren & de Jong, 2007). Therefore, investigating the adoption of sustainable development in relation to building activities and the built environment is essential for achieving significant gains in moving toward a more sustainable society. Conversely, it has been noted that words like *sustainability* and *development*, while seemingly contrasting notions, are widely used to indicate future plans to find solutions to world problems (Adams, 2009, p.1). Behind the concept of sustainable development lies the endeavour to solve global environmental problems, such as dealing with climate change, biodiversity depletion, and concerns for natural preservation in the Western World.

2.3.2 Sustainable development

The concept of sustainable development began to be widely adopted following the 1972 United Nations Conference on the Human Environment in Stockholm (Adams, 2009, pp. 54–57; Magee et al., 2013). The most notable result of the conference was the creation of the United Nations Environment Programme (UNEP) to act as a governing council for environmental programmes (Adams, 2009, pp. 59–64). Coincidentally, the idea of environmental limits or constraints on development was explored through the release of the Club of Rome’s *Limits to*

Growth report in the mid 1970s, as discussed above (Meadows, 2007, pp.191–193). From this emerged the observation that the basic necessities of life provided by the planet such as food, water, clean air, and health are threatened by harmful human interventions (Turner, 2008; Costanza, 2006; Adams, 2007, p.71).

In the early 1990s, William Rees and Mathis Wackernagel developed the concept of the *ecological footprint* as an indicator of environmental sustainability. It describes the amount of productive land and water ecosystems a defined human population need to produce the resources required to support itself and to absorb the wastes produced at a specified material standard of living, given prevailing technology (Monferda et al., 2004; Ewing et al., 2010; Lyndhurst, 2003). The ecological footprint is measured in global hectares (gha), found by dividing the average productivity of land (for land based resources) and sea (for sea based resources) by the population using these (Ewing et al., 2010). Hence, for humanity to achieve sustainability, the total world population footprint must be less than the resources taken from the total land and water area of the earth on a sustainable basis. As of 2012, it was estimated that humankind has been using natural capital 1.6 times as fast as nature can renew it (Global Footprint Network, 2016), indicating that humans are over consuming resources and operating in an unsustainable manner (Figure 2.2).

Figure 2.2 The world ecological footprint in global hectares (gha) per capita has increased significantly over the past 50 years. Source: Global Footprint Network

As mentioned, sustainable development was noticeably included in the manuscript of the foundation of the World Commission on Environment and Development (WCED), *Our Common Future* in 1987, or what is known as the Brundtland Report. In this, the relationships between the three dimensions of ecology, sound economics, and social well-being were explored. It initiated the idea that development thinking needed to be ‘greened’ (Schubert & Láng, 2005; Magee et al, 2013; Adams, 2009, pp.3, 75–77). According to Adams (2009, p.77) the Brundtland report’s definition of sustainable development is based on two concepts: the basic needs of the poor, and the idea of environmental limits from the impact of human activity. Accordingly, the basic notion of sustainable development is achieved when the three dimensions of economic, environmental, and social coincide or overlap (Figure 2.3). This is also the weak sustainability model.

Figure 2.3 The basic concept of sustainable development.

The document was concerned with the tension between the aspirations of people for a better life and the environmental limits imposed by nature and the dangers of environmental degradation. However, moving from the ethical and visionary level of sustainable development to an operational level needed further developed prototypes. In 1992, the concept of sustainable development became widely known through the Rio Conference and *Agenda 21*. All conferences that set the direction of sustainable development had a remarkably consistent core of ideas; a ‘mainstream’ strongly influenced by science, ideas about wildlife conservation,

concerns about multi-lateral global economic relations, and emphasis on the rational management of resources to maximise human welfare (Adams, 2009, pp.90). However, at no time was there a description of what *human welfare* might look like within the idea of environmental limits.

Burns and Witoszek (2012) stated, “sustainability is not just about policy and justice, it is first of all about ethics and aesthetics.” Yet in most sustainable development conversations, there has been very little acknowledgement of the role of culture or the sense of belonging that people often feel in their living patterns, apart from protecting native traditions (Burns and Witoszek, 2012; Kulman & Farringham, 2010). It seems the focus has only been on solving environmental, economic development, or energy problems. Concerns about culture, ethnicity, religion, and values that have been the principle issues of conflict throughout history have received little attention. The neglect of culture has meant that major drivers in contemporary society have been overlooked. Cultural sustainability, that has evolved over time and been shaped by various factors and conditions, should be an important dimension of sustainable development (see Section 2.4).

2.3.3 Mainstream sustainable development

Adams (2009, p.116) identifies three important groupings of thought within the idea of mainstream sustainable development: *market environmentalism*, *environmental populism*, and *ecological modernisation*. Market environmentalism is based on continued economic growth, and therefore is in strong opposition to the ‘limits to growth’ idea prominent in the 1970s, it is quite literally ‘business as usual’ (Adams, 2009, p.117). Environmental populism draws on the ideas of the power of civil society and is based on the participation of ordinary people in decision-making. This idea is based on voluntary cooperation in a process within which people have the possibility of intervening (Adams, 2009, pp.118, 129). Ecological modernisation combines economic growth with environmental improvement and is based on the belief in science to solve human and environmental problems and depends on governmental regulations to promote innovation in

environmental technology (Adams, 2009, pp.125–126).

Ecological modernisation, as a mainstream sustainable development concept, was first developed in theoretical terms in Sweden in the early 1980s, and has been used as a policy discourse for the environment in Sweden and Netherlands, where over-exploitation of resources is no longer accepted as routine (Fudge & Rowe, 2001; Adams, 2009, p.12). The growth of the concept started with a focus on technological innovation and bias towards market solutions and then turned to taking a more moderate view on technological innovation with an emphasis on institutional and cultural dynamics, and socioeconomic change. In the final and current stage, it has focused on dealing with international issues such as consumption and global processes, where environmental problems are conceptualised as challenges for social, technical, and economic reforms (Fudge & Rowe, 2001). An example of such development would be *Hammarby Sjöstad* in Sweden. Founded in 2002 this was to be Stockholm's biggest urban development project with 11,000 residential units housing just over 25,000 people (Figure 2.4). The project involved the redevelopment of a 'corrugated steel shantytown' south of Stockholm into an eco-district including extensive reconstruction and integration of technical infrastructure, mobility and communication infrastructure, building infrastructure, and to some extent green-blue infrastructure. Another strong feature was the system of interdisciplinary planning of physical flows of energy, water and waste. The *Hammarby model* included energy conservation measures in which the goal was to reduce energy for heating by 50% and use electricity more efficiently compared to the Swedish average (Ignatieva & Berg, 2014; HSEF, 2007).

Figure 2.4 Hammarby Sjöstad, 2002, Stockholm. Parts of the project showing areas planted with reeds where a popular system of recreational boardwalks was built.

Source: Ignatieva & Berg, 2014.

Although it could be argued that a 50% heating reduction is not a large step in making sustainable buildings, ecological modernisation was also built on the principle that institutions could change and the actors within them could learn, leading to a shift in values and a wider greening of society at the same time (Adams, 2009, pp.125). However, Herman Daly (2002, p.11) has insisted that economic growth has made the world poorer, not richer. He stated that reducing poverty could not be attained by growth because growth would increase environmental and social costs faster than it would increase production benefits. Moreover, he has posited that true economic growth will not increase welfare as long as goods and services that mainly satisfy relative rather than absolute wants are produced.

Ecological modernisation and engineering practice have made considerable progress in several countries, however the contribution of science and technology to the mastering of environmental problems remains questionable (Cohen, 2006). Furthermore, technology could become an environmental threat without effective institutional control and with an emphasis on reductionist rather than holistic science (Gasparatos et al., 2009).

In the Brundtland report, little was said of the way sustainable development should be accomplished. When moving from an ethical and visionary level of sustainable development to an operational level further development models are needed.

Sustainable development in the free market environment of the 1980s was in many ways contradictory to the environmental limits to growth. Furthermore, the hard questions of poverty in developing countries and environmental degradation remain unanswered.

2.3.4 Sustainable building

Sustainable building is a holistic and multidisciplinary approach, increasingly advocated for buildings as well as infrastructure (UNEP, 2003, p.5; Graham, 2003, pp.3, 4). This represents a shift towards considering a sustainable built *environment* with construction being only part of the process. In addition, Sustainable Construction Methods and Techniques (SCMT, 2004, pp.10–11) stated the challenge for sustainable building is two-fold; on the one hand, it entails meeting the challenges of the inter-relationship between buildings and a range of factors including activities within and around buildings, resource use, and environmental objectives; and on the other hand, these have to be implemented while considering local building norms and practices. Furthermore, sustainable building involves an integrated solution that accounts for environmental considerations while at the same time attaining acceptable levels of quality of life, comfort, and social, economic and cultural values.

There are many examples of sustainable building, but these are far from being a *stream* and much less a *mainstream* (SCMT, 2004, p.6). Most are also focussed on a single building and its activities rather than considering the wider built environment. The Mobbs' House, built in 1996, was launched as an example of renovating an ordinary terrace house in inner city Sydney to become a sustainable house. The owners adapted their dwelling to make it environmentally sustainable, and almost entirely self-sufficient in terms of electricity use, water,

and waste disposal. For them, a sustainable building means living in a place that produces water, energy and manages wastewater in a way that sustains life physically and financially (Mobbs, 1998, p.12). According to Mobbs, the project also set a *good example* of sustainable attitudes, concepts, and practices that were published in the hope they would inspire others. Yet, to live sustainably on the planet requires efforts that extend beyond individual initiatives to seeing buildings as part of the ecology of the planet and building as part of a living habitat (Roaf et al., 2001). It also requires a type of collective vision that is in tune with and preserves the earth's organic systems, in other words *sustainable development*.

In progressing towards building sustainability, the United Nations Environmental Programme (UNEP) called for a change in building patterns warning that expansion of the built environment at current levels would have numerous environmental and social impacts, by destroying or disturbing natural habitats and wildlife over 70% of the earth's land surface by 2032. The latter is mainly driven by increases in population, economic activity, and urbanisation (UNEP, 2002, pp.6–9). This means a lack of relationships between buildings and natural systems and as a result the effects of buildings activities on nature have often been overlooked (McDonough & Braungart, 2003). Hence, building sustainably is about building relationships between people, as well as between the building and the natural environment, the outcome of which might be manifested in changes made to people's lives, the built environment, and the health of the natural environment (Yeang, 1995; Graham, 2003, pp.17, 18).

McDonough and Braungart have advocated for a cradle-to cradle approach to architecture and the building industry involving materials, buildings, and urban settlements. This approach “sees human systems as nutrient cycles in which every material can support life” (McDonough and Braungart, 2003). This involves designing materials as biological nutrients that can nourish nature after use, or as technical nutrients that circulate through industrial systems in closed-loop cycled production, recovery, and remanufacture. Therefore, instead of considering material use as a waste management problem, cradle-to-cradle design is based on

the nutrient cycles of nature, in which there is no waste, and which are driven by the incoming energy of the sun.

Buildings mainly depend on natural means (grown and extracted materials) to provide construction resources and to assimilate construction waste. In use a building will need energy to run it and a means of absorbing the wastes of those who use it. Consequently, it is important to account for the total environmental impact of every building. Hence, addressing building sustainability includes considering the whole cycle from planning to demolition and disposal. Life-cycle analysis (LCA) is a powerful technique commonly used to deal with the impacts of a building by combining all of the environmental and health impacts of its essential materials, construction process, its operation and refurbishment, and eventual demolition (Graham, 2003, p.26; SCMT, 2004, p.23; USEPA, 2014). LCA considers the joint efforts of all the actors involved in the building sector from material producers to end-users to be important (SCMT, 2004, p.23) (Figure 2.5).

In order to analyse the environmental impact of a building project using an LCA approach, major targets for sustainability must be considered. These include energy efficiency, reduction in use of resources that cannot be replaced, reduction of fresh water use, reduction of energy needed for packaging and transport, minimisation of impact on biodiversity, reduction of waste, reduction of hazardous substances, and quality of the indoor climate (SCMT, 2004, pp.23–26; BRANZ, 2006). The EU Working Group for SCMT (2004, pp.23, 24) have recommended a list of measures for analysing the environmental impacts of buildings both pre- and post-occupancy. The pre-occupancy (construction phase) includes use of energy, use of water, use of packaging, transport movements, and waste leaving the site, while post-occupancy includes the energy and water in use, as well as the quality of the indoor conditions. SCMT (2004, p.13) also stated that a sustainable building is performance based and independent from any architectural style.

Figure 2.5 Building life-cycle considerations, (Source: Graham, 2003, p.29).

A life-cycle systematic approach is also appropriate for the planning, design, and maintenance of buildings intended for an extended lifetime because of design flexibility (Graham, 2003, pp.208, 214). Cole (2004) reflected on how the LCA approach can help to organise environmental issues within a framework of building environmental assessment methods to provide clarity and structure. However, he warned of the negative effects of rigid categorization within the field of environmental design research by assuming the built environment has a fixed quality. He thus referred to the importance of considering the process of change in buildings as a consequence of social change, thus showing people to be as important as buildings.

A life-cycle analysis of an individual house in New Zealand found operating energy to be a significant component of life-cycle energy for common house construction types (Mithraratne & Vale, 2004, p.483). It found items such as, finishes, appliances, and furniture also made a significant contribution to the total

environmental impact of the house over its useful life due to the relatively short life of these items. The study stressed that additional insulation in existing structures would significantly reduce the overall environmental impact (see Section 4.3) (Mithraratne & Vale, 2004, p.491).

In relation to the issue of limits (Section 2.2.4), and because renewable resources are generally directly connected to land and hence natural capital, land may also be in short supply both now and in the future as the human population grows and the demand for land increases. This returns to the issue of whether it is possible to have true sustainable buildings based on conventional models that continue to rely on the components of natural capital to supply the resources to build them.

2.3.5 Refurbishment of existing buildings

The sustainability of existing buildings is an important issue in New Zealand (Easton, 2007). Both in New Zealand and the EU, the existing building stock far exceeds the number of newly constructed buildings (annual replacement is 1–2% in the EU (EU, 2010), hence refurbishing the existing building stock towards sustainability is vital (Thuvander et al, 2012; Xing et al, 2011). Nicklaus Kohler (1999) stated:

“the objective of sustainability is not to improve qualitatively the building stock, but...to develop techniques to maintain, refurbish, and adapt new technologies to fit the existing buildings to new requirements and to adopt new technologies to fit the existing buildings.”

So, if old buildings are integrated with technologies in such a way as to satisfy certain criteria for economic and ecological sustainability, a combination of built heritage conservation and environmentally responsible building could contribute toward total sustainability in the built environment.

Refurbishment processes can be complex and there is the potential to misjudge architectural, cultural, and social values in favour of measures to improve a building's environmental performance. Hence, a systematic approach to sustainable building concerning the links between components, materials, and functions of the building is necessary (Brand, 1994, p.94; Cole & Lafreniere, 1997). Based on the ideas of Frank Duffy, Brand created a time based model for the different layers in a building (Figure 2.6). At one end of the scale, the site has the slowest change cycle, while at the other interior materials, called *stuff* in Brand's model, have the quickest. Layers with a shorter life span should be designed for change (Brand, 1994 p. 12–17). Brand's ideas were influenced by the biologist Robert O'Neill who, through studying ecosystems, concluded that the dynamics of the system “will be dominated by the slow components [i.e., the site in the building context], with the rapid components simply following along” (Brand, 1994, p.17). Brand (1994, p.17) also maintained “buildings rule us via their time layering at least as much as we rule them, and in a surprising way.”

Figure 2.6 Shearing Layers of Change.
Because of the different rates of change of its components, a building is always tearing itself apart.
(Source: Brand, 1994, p.13).

Cole and Lafreniere (1997) examined the process of translating environmental information into effective design decisions. They expanded the ideas of Duffy and Brand into a framework for environmental design with three different scales. Based on life span, their progressive framework established an order between materials and components. The scale-based framework referred to system boundaries in space, such as building, site, neighbourhood, city, and region. The contextual circumstances framework referred to the physical environment as well as to politics, economics, and cultural aspects. In addition, flexibility and

adaptability were mentioned as key words in sustainable building. Brand affirms, “An adaptive building has to allow slippage between the differently-paced systems of site, structure, skin, services, space plan, and stuff” (Brand, 1994, p.20). However, reducing the use of fossil fuels through energy efficient refurbishment of the building fabric, itself a fixed system, is also seen as essential (Xing et al, 2011; Davies & Osmani, 2011; Hong et al, 2006). Xing et al. (2011) have proposed zero carbon refurbishment as an approach to minimizing the use of fossil fuel through integrating the building with renewable energy systems. Their study reviewed relevant technologies and sorted design considerations into hierarchical pathways. These included controlling the flow of energy through the building envelope, with two key requirements of a space heating energy demand lower than 15 kWh/m²yr and a total primary energy demand lower than 120 kWh/m²yr; application of insulation materials with lower thermal conductivity such as glasswool, rockwool, and vacuum insulated panels, according to location; reduction of lighting energy use by 75–90% compared to conventional lighting through combining day lighting, energy efficient lighting, and control; revision of heating technologies in favour of solar panels, heat pumps, combined heat and power (CHP), biomass boilers, district heating, and thermal storage; improvement of indoor air through natural or mechanical ventilation techniques; and generation of zero or low carbon heat and power to meet energy demands on site.

Referring to the notion that sustainable building is a holistic approach (Section 2.2.3), Raymond Cole (2004) stated, “The environmental debate over the past three decades has shifted from an attitude of survival to one of responsibility and stewardship.” This view is supported by van Bueren & de Jong (2007) who maintained that the focus of research and the everyday practice of sustainable buildings had shifted from that of the 1970s and 1980s where the emphasis was on refining the environmental performance of buildings, to a *systems* perspective where the sustainability concept requires a more comprehensive approach to planning, taking into account wider spatial scales than just the building level. Consequently, Konstantinou and Knaak (2011) systematically organised the

different options of retrofitting post-war houses in Germany into categories, creating a *toolbox* for the design of refurbishment projects. Considering the diverse effects of various measures on energy demand, the objective was to create a database of the possible measures that could be implemented in refurbishment projects in order to assist effective choices without compromising the intentions of the designer or the client. The information was organised in a matrix of the key components of the building. These were external walls, basement, roof, windows, balcony, ventilation, and heating sources. These could be separate or combined, depending on the specific requirements of the project.

The systems perspective views the urban structure and infrastructure of the built environment as going beyond the physical to include the social system. Van Bueren and de Jong (2007) maintained that any interventions in the physical system had implications for the social system. They observed that neighbourhoods are not only physical entities, but also urban patterns and social networks. In addition, certain buildings have significant design or historic values that could outweigh their poor environmental performance. Therefore, any attempts to improve the environmental performance of the built environment had to make allowance for the interrelated and integrated human, social, and economic components.

In the history of human settlements there is evidence of cities, towns, and places where traditional building patterns have been integrated with the urban fabric (Alexander, 1999, p.73). The consequent coherence between the environmental, social, cultural, and economic aspects of the urban pattern form clear evidence for ecological and sustainable solutions that have evolved over time through generations.

2.3.6 Sustainable design and technology

Guy and Farmer (2001) have highlighted the conceptual challenges of the meaning of sustainable buildings through examining the relationships between the diverse technical design strategies and the concepts of ecological building, as

well as outlining a social constructivist perspective on the development of sustainable architecture. Consequently, they identified six *competing* types of ecological design: eco-technic, eco-centric, eco-aesthetic, eco-cultural, eco-medical, and eco-social. They also alleged the competing environmental debates about the role of technology are not the result of uncertainty, but rather due to the existence of *contradictory certainties*, concerning the environmental problems humanity faces and the solutions available. Therefore, their view of sustainable design is an on-going transformational process within which different actor interests and struggles are located, including environmental innovation becoming established in commercial development practices. Furthermore, Kua and Lee (2002) pointed to the need to accelerate the acceptance of technology in the building sector explaining, “New technologies developed in the construction industry, especially those involving new materials and fundamental systems, typically take 10–20 years before they are widely accepted”.

In reflecting on the future of technological development in relation to notions that may shape future environmental attitudes, Cole (2004) made the observation that technical issues are easily quantified whereas human impacts are not easily explained, given that industrial society is founded on a scientific and technical paradigm. He also pointed out that social and cultural issues have *co-existed* with technical development issues rather than being *informed* by them. This gulf between the sociocultural and technological has meant that a great deal of critically important work within social and behavioural science has not filtered through technological considerations, and thus failed to have a direct influence on design.

For the creation of a better society, information on the role of the environment and its issues must be considered and meaningful change must happen to the attitudes of society, including attitudes in the technological sector. This means a shift in expectation influenced by the context of limited growth (Magee et al., 2013). Pirages (quoted by Cole, 2004) has suggested that the new context would require design skills and effective decision making. This means having the ability

to work within additional constraints and design in terms of the materials, and energy available, and to rethink the contemporary definition of design values towards creating a social and living environment as opposed to just a physical one.

2.3.7. What does ‘sustainable building’ mean in this research?

From what has been discussed in Sections 2.1, 2.2.1, 2.2.5, 2.2.6, and 2.3.4, sustainable building concerns the complex relationships between building activities, the built and natural environments, as well as determining the influences on the social, human, and cultural aspects. In light of this, this research argues that:

A sustainable building could be described as one that adopts processes that are environmentally responsible, is resource-efficient throughout its life-cycle, is part of a living habitat and culture, and recognizes that there are limits to the resources available.

The challenge of sustainability in the second decade of the third millennium of the Common Era remains that of Kenneth Boulding’s metaphor as expressed at the beginning of this chapter: one earth, turning slowly in space as a home for humankind. Similarly, Adams (2009, p.15) showed that human wellbeing, poverty reduction, and the state of the global environment remain closely linked.

2.4 Social and cultural dimensions of sustainable buildings

The idea of environmental ethics and the human dimension in relation to architecture has inspired a new research basis for sustainable buildings (Pedersen-Zari, 2007). Due consideration for sustainability is at the essence of both contemporary existence and architecture, and suggests re-thinking the relationships between *place*, habitat, and nature (Sharr, 2007, p.26). Sustainability thinking stems from realising the consequences of depleting natural capital and the planet’s inability to support current global living patterns of consumption and

growth indefinitely (Meadows et al., 2004). Similarly, place has a relationship with social and cultural capital, hence the concept of the spatial ordering of social life is space-specific. It is not merely a conditional fact of being.

2.4.1 Vernacular architecture

Vernacular architecture is understood to mean the building of the people and built by the people, rather than building through professional designers. Vernacular buildings evolve and their traditions incorporate knowledge about long-term problems, awareness of cultural values and social practices, and methods based on the use of immediately available and low cost materials (Cromley, 2008; Brand, 1994). Families in an established settlement would cooperate to build or maintain their houses, possibly under the direction of individuals skilled in crafts (Vale, 1976, p.108).

This process can be observed in traditional Japanese buildings that correspond well and harmoniously to local climate and cultural traditions. Traditional houses in Edo, Japan have very thick thatched roofs, high wooden floors, thick earth walls, and paper sliding doors that open wide (Figure 2.7). Spaces are influenced by cultural values and practices. The idea that a room's true beauty is in the empty space within the roof and walls comes from Japanese *Taoism*, an adopted philosophy (Black, 2000; Todd & Geissler, 1999). It holds to the aesthetic ideal of emptiness, believing that the mood should be captured in the imagination, and not dictated by what is physically present. Flexibility is a strong theme in traditional Japanese dwellings. A distinguishing feature of the space is *shōji*, whereby using interior sliding walls or paper screens the size of a room can be altered according to social requirements. Similarly, the separation between inside and outside is not absolute as entire walls can be removed, opening a residence to visitors (Black, 2000, pp.6–11).

(a) Exterior view.

(b) Interior view.

Figure 2.7 Traditional Japanese houses in the city of Edo, part of modern day Tokyo, 17th Century. The house corresponds harmoniously to local climate and cultural traditions.

Source: http://en.wikipedia.org/wiki/Japanese_architecture#cite_note-hozintro-1

In warmer climates, particularly in the hot cities and towns of Iraq, Saudi Arabia, and India, the urban pattern is one of compact arrangements of clusters of attached houses, at least two storeys high. To be able to provide shelter from the hot sun, houses in a cluster are linked via narrow and non-straight alleyways. Mainly for social and cultural purposes and as a solution to extreme environmental conditions, houses open inwards to a central courtyard around which the various rooms are organised (Warren & Fethi, 1982). Courtyards allow for cross ventilation and light penetration but are often shaded against the overhead sun through proper orientation and building projections. The thick outer brick walls of such buildings are often shaded with shutters, terraces, balconies and *mushrabiya* (ventilated and grilled timber cantilevered windows) (Roaf et al., 2001, pp.20, 21). In such climates rooms can become vertical or horizontal buffers, and can keep the sun off mass walls that would transfer the heat inwards by conduction (Figure 2.8). The urban pattern of these houses works in harmony with the social and cultural patterns of the communities (Warren & Fethi, 1982).

Figure 2.8 Time lags between indoor and outdoor temperatures in Iraq and India. The house opens inwards for social and cultural purposes as well as being a solution to extreme environmental conditions. Source: Roaf et al, 2001, adopted from Matthews, 2000.

2.4.2 Sustainability and adaptability in vernacular buildings

Traditionally, vernacular buildings are well established as incorporating generational knowledge about long-term problems and thereby becoming responsive to local ecological systems and local society (Cromley 2008; Alexander, 1999; Brand 1994). Traditional buildings in many parts of the world have developed particular patterns so they grow according to well-defined stages (Alexander et al, 1977). This practice is common in rural New Zealand where houses and farm buildings go through phases of incremental growth in their lifetime. More sophisticated are the village houses of Malaysia, probably because the culture is more stable and established. The Malay house, with its refined, varied means of extending from the original *core house*, has developed a pattern for incremental growth (Figure 2.9). It creates near perfect solutions to the control of climate, multifunctional use of space, flexibility in design, and a sophisticated system, where the house can extend in accordance with the growing needs of the family. Together this leads to a more socially and ecologically sound environment and one that fosters a strong sense of community within a group of similar houses (Brand, 1994, p. 137; Yuan, 2010).

Figure 2.9 The Malay house is a response to local ecological systems and culture. As a vernacular building, it has developed solutions both to the control of climate and the need for adaptability and growth. Source: Brand, 1994, p.137.

Brand emphasised that change in most contemporary buildings is influenced by social and cultural factors and in many cases such change has come about through *copying*. He calls it the *informal* pathways of influence, compared to the formal pathways of an architect influencing another architect stating, “People seldom innovate...they borrow” (Brand, 1974, pp.139, 140). In many occasions, a building form becomes so wildly popular that its design is assumed to be anonymous, or *folk*, when in fact it was some individual’s bright idea (Brand, 1994, pp. 140 – 143). New Zealand adopted the Californian bungalow at the beginning of the 20th century and it soon became one of the local standard house types. The most distinctive feature of the bungalow is the wide, low-pitched roof extended out over a verandah. It was designed in California to deflect rain and

to welcome tropical breezes, but it is still used in contemporary New Zealand houses to shelter outdoor sitting areas (Salmond, 1991).

Relatively recently human living patterns have been affected by changing ecological patterns. The current growth in population size as well as per capita resource consumption has put pressure on the amount of resources processed from the biosphere by the economic system, resulting, among other things, in the vulnerability of existing social and ecological systems (Meadows et al., 2004; Pretty, 2011; Adams, 2009; Berkes & Folke, 1994). The loss of biodiversity is also responsible for the loss of cultural diversity, as both have undergone an unprecedented rate of deterioration in recent decades, with the latter shifting towards monoculturalism (Pretty, 2011). On the other hand, as communities endeavour to resume their connection with the environment, and as a result improve their own resilience, the challenge arises of how adapting modern living practices will affect eco-cultural systems (Gadgil et al., 1993).

In this context, this research includes rethinking the ecological paradigm by using the multi-dimensional concept of critical natural capital so as to be strongly linked to and guided by social, cultural, and heritage principles (see Section 1.4.3, Section 2.4). It also explores the potential for intercultural influences, in a multi-cultural society, in terms of adopting sustainable practices, having regard for natural resources, and finding suitable environmental solutions. The aim is that once again Otatara Hills will become a sustainable place.

2.4.3 Culture, nature, and conservation

Conservation by people can arise from the belief systems that comprise human religions and that are embodied in diverse social institutions (Gadgil et al., 1993, p.151). As mentioned before, ecosystems evolve over time, as do cultural institutions, which act to define locally acceptable practices and behaviours. In some cases, these have greater influence on people's decisions and choices than economic indicators. Accordingly, it is important to understand the interactions between culture and natural biodiversity in terms of identity, ecological

knowledge, religion, aesthetics, and social status (Loomis, 2000, pp.893-896). The Māori success in preserving nature stems from establishing it in the form of spiritual and culturally powerful symbols that command a sense of respect (Berkes, 2009, pp.151–153). This is manifested in the significance of the LC's location at Otatara Pa, which contains the history and *mana* (power, influence) of local Māori and their links through genealogy to people and places in New Zealand.

The diversity of cultures in New Zealand brings about a spread of meaning, leading to the development of relationships, common understanding, and knowledge building between indigenous and non-indigenous people, providing a range of biodiversity outcomes. This nature-culture continuum or interconnection has existed in the past, is in the present, and is likely to be sustained in the future. However, natural area conservation by the indigenous Māori community is often based on multiple objectives including sustainable use and livelihood needs, cultural values, self-government, and economic development (Berkes 2009, pp.153, 154; Loomis 2000, pp.897–900).

One of the objectives of the LCP is to aspire to deeper partnership between tradition and knowledge in order to arrive at solutions for sustainable living (see Section 1.4.3). Such actions include, among other things, strengthening the network of community conservation initiatives in the local natural environments and carrying out ecological and sustainable projects that respond to community needs.

2.4.4 Culture and resilience

There are intimate links between people and their environmental systems and these can affect an ecosystem's capacity to respond to external disturbances without moving to a changed state (Pretty, 2003; Pretty, 2011). It now seems that human beings and their ecosystems are more vulnerable because of monoculturalism and deteriorating biodiversity (Pretty, 2011). The level of resilience in human socio-ecological systems is related to connections between

technology, in terms of utilising assets, and social capital, in terms of plans for collective actions that result in outcomes that conserve natural capital (Costanza et al., 2007).

Developing an ecological culture includes social and cultural institutions aspiring to retain their connections with the local environment, thus improving the resilience of the cultural system in the face of external environmental pressures (Pretty, 2003). Rotarangi and Russell (2009) argue that the maintenance and evolution of identity and the culture of indigenous peoples and communities is premised on such resilience and the methods local societies use in response to their local ecologies. However, social-ecological resilience has so far mostly been discussed in the absence of the critical cultural dimensions and holistic concepts that define indigenous communities (Rotarangi & Russell, 2009).

One of the objectives of the LCP is for the community to regain its connection with the environment in order to improve its socio-cultural resilience (see Section 1.4.3 and Section 6.5.6). This is achieved through advancing the notion that socio-cultural systems not only comprise the defined social frameworks of the community, but also include adopting a holistic approach to information by integrating worldviews with identity, values and distinct cultural influences (Brand, 1994, pp.132, 133; Cole, 2004; Graham, 2003, pp.3, 4). This approach was significant in designing the mechanisms for interacting with the groups engaging with the project activities at design, build, and visitor stages (see Sections 7.1, 7.4, and 7.6).

2.4.5 Concepts of cultural and social capital

Human cultures have been shaped by nature and local ecological systems (Cochrane, 2006), and natural, cultural, and social capitals have combined to provide the goods and services necessary to increase welfare (Pretty, 2011). The concept of cultural capital refers to the underlying factors that provide human societies with the means and adaptations to maintain themselves in their environment. It can be conceived as the interface between natural and human-

made capital (Cochrane, 2006). Yet the intense modification of the environment by people has resulted in dramatic worldwide declines in natural and cultural capital. Social and ecological systems are becoming more vulnerable through the disruption of livelihoods, governance, institutions, resources, and cultural traditions (Pretty, 2011).

The quantity of natural capital resources processed from the environment by the economic system is affected by an increasing population, and per capita resource consumption, and the reduced capacity of nature to provide the resources and sinks demanded of it (Adams, 2009, pp. 144–147; Berkes & Folke, 1994). Adams (2009) compared the projected *empty* world scenario of the past with that of the *full* world today, where the economic system has already started to interfere with the biosphere through excessive human demands. Goodland et al. (1993) also stress the continuing reality of environmental limits and the fact that the human ecological system has to exist within the biosphere, on which it depends and of which it is part.

Cochrane (2006) has regarded social capital as equally important as natural capital, with human developments generally seen in changes in social indicators such as nutrition standards, participation in education, levels of public and welfare services, and environmental indicators of air and water qualities. This is an attractive concept for those who believe that social cohesion is significant for sustainable human and economic development, especially poverty alleviation (Bourdieu, 1984). In its modern form, social capital refers to the models and networks that enable collective action in a society. Social capital as a concept addresses the economics of the organizations that govern human interactions in areas such as resource use and seeks solutions for conservation and maintenance of social and ecological systems (Adams, 2009, pp. 144–147; Pretty, 2011). Discussions concerning issues such as the management of common resources, like the air, have been particularly influential in changing the understanding of how people collaborate over the use of resources. This links back to the vernacular traditions, discussed earlier. In these people had to collaborate over limited

natural resources, as in the example of Iraq, where everyone had to follow the pattern of narrow access alleyways if the whole urban area was to be kept cooler.

2.4.6 Otatara Arts Centre, the beginning of a culture

The concept of *place* in relation to space, time, location, event, living patterns, and sustainability is of relevance to this research. As mentioned in Section 1.4, the Otatara site where the Otatara Arts Centre was established in the late 1970s was a place of special character, through connecting modern and traditional knowledge in order to produce better educational and cultural outcomes for the community. In this context, the Otatara Arts Centre programme, as it was then known, was established up on Otatara Homestead Site after the original Art Room was no longer big enough to accommodate the programme. There the programme operated from an existing stables building, built in the early 1900s as part of the original homestead (Bahho, 2013). From the outset, the programme regarded social and cultural dimensions as an integral part of a sustainable and ecological solution. So the building, which was run down and with only very basic facilities, was refitted and refurbished predominantly using recycled materials and in-house labour. It was a humble beginning, but was also the place from where the arts programme started establishing the outreach process to enable local people to reach their potential both as artists and community members. The aim was to bring something to the community in terms of culture and resourcefulness, as well as running an arts programme (Bahho, 2013).

The Otatara Arts Centre developed with all buildings around a central courtyard (see Figure 1.3 for location). Most of the working activities happened in this open space (Figures 2.10 and 2.11). The layout was influenced by the space patterns of the *Wharenumi* (communal Māori Meeting House). It was also derived from the way the programme operated as the objective was for students to learn from each other's experience, so they needed to be able to see each other all the time, even if they were focusing on different workshops or techniques. This ability to see everything also included tutors and visiting professionals. Consequently, there was a process of cross fertilisation of information, which was seen as valuable and

which developed into a culture of enquiry and expansion of information (Scott, 2012 August 18).

Figure 2.10 Otatara Arts Centre on Otatara Hill, Jacob Scott drawing, 1985.

(a)

(b)

Figure 2.11 Images of Otatara Arts Centre, Alan Neilson photos, 1997, (a) from the courtyard looking west (b) from the hill behind looking east.

A significant aspect of the Otatara set up was the constructive relationships with the community, particularly the local arts and Māori communities. Various activities and workshops were organised involving local professionals as well as personalities from outside the area and overseas. At that time Otatara was seen as the centre of the arts community (Cooke, 2012 August 17).

On the other hand, and because of the *togetherness* of both cultures, Māori and European, there developed at the Otatara Arts Centre a kind of Kiwi Culture that was formulated through the exchange of values, language, society, methods, and beliefs (Waugh, 2012 August 17).

2.4.7 D-Block buildings, community and culture

In 1991, the Otatara Arts Centre (now the Visual Arts and Design (VAD) Programme) received new buildings, known as D-Block, built on another site in the EIT main campus (see Figure 1.3 for location). In the layout of D-Block, the staff and students strove to maintain relationships with both the environment and culture. The community connections with the old set up at Otatara continued in terms of providing studio facilities and a cultural presence. The new D-Block buildings that still accommodate the VAD programme at Eastern Institute of Technology, Hawke's Bay offered a solution for connecting knowledge with tradition to produce optimal outcomes for both nature and culture (see Section 2.4.5). The original buildings were designed by the renowned local architect John Scott in 1991 and were twice expanded, in 1994 and 1998. Scott's idea was that unique building systems could be generated through an emphasis on incorporating local and traditional knowledge systems (Figures 2.12 and 2.13).

Figure 2.12 D-Block, Visual Arts and Design buildings at the EIT Hawke's Bay campus showing the second 1998 extension (in blue). The original 1991 design (in grey) was by John Scott.

(a) Courtyard view

(b) View from the outside

(c) Courtyard view

Figure 2.13 2012 images of the current D-Block. The buildings strive to maintain a relationship with both the environment and culture.

The original buildings were designed around two courtyards to act as the social, cultural and educational interface between occupants. The design comprised five large square buildings used as studios and workshops. Scott's idea was that the square shape offers maximum adaptability for multi and flexible use and is the

most affordable in terms of achieving maximum volume. The 10mx10m space units had an arrangement of indoor and outdoor covered links. These were wide enough to be utilized as working or exhibition spaces in their own right. These links also offered a system for possible expansion, similar to the idea of the Malay house (see Section 2.4.2). The key feature of the design was the spatial integration between interior spaces and the surrounding environment. All buildings had timber frame wall and roof structures and concrete floors. The structure suited the building's purpose and objectives being efficient, organic in terms of integration with green spaces and showing the materials in the structure, and economical in material use. The walls were clad externally with fibre cement boards, while interior walls and ceilings were finished with particle (chip) boards. The mechanical devices needed for heating and ventilation were very simple, as the blocks relied on natural light and ventilation, so their requirement for energy was low. The design concept of D-Block was not aimed at being extremely comfortable and convenient, as the focus is more on social and cultural values, and economic necessities (Cromley, 2008).

The D-Block building concept is an example of a design for a campus building that is coherent, well-formed, and with strong reference to Māori traditions in terms of layout organization and features. In doing so it makes something much more sustainable, being harmonious with the local social and cultural traditions, with less technology and fewer energy demands.

2.5 Summary

Human beings rely on a fixed reserve of resources from the earth and because these are finite there is a *limit* to their availability. The issue is compounded by trends in contemporary culture promoting consumerist attitudes of obtaining ever more material possessions. Sustainable building also entails determining the complex relationships between building activities, the built environment, and the natural environment, as well as considering and respecting the social, human, and cultural aspects. This task becomes more complicated if sustainable buildings involve existing structures. The research objectives have been formulated from

the viewpoint that the social and cultural dimensions are an integral part of a sustainable and ecological solution. The history of human settlements is full of relevant examples that have allowed sustainable building patterns to evolve, therefore underpinning the generation of sustainable ways of living.

Chapter 3: People and sustainability

“The sustainability crisis is a behavioural issue, and not one simply of technology, production, and volume.”

Jonathan Chapman (Design for (Emotional) Durability, 2009, p. 29)

This research aims to engage with pro-environmental behaviour as a result of environmental attitudes, with a focus on understanding people’s views of environmentally related matters, mainly in relation to the built environment, and the importance of influencing their behaviour to become more environmentally aware.

3.1 Environmental attitudes

Many definitions have been proposed for the term *attitudes* reflecting the way it has been researched and conceptualised (Milfont, 2007, p.10). Dunlap and Jones (2002, p.483) defined environmental attitude as “concern for environmental quality or environmental concern”, Schultz et al. (2004) used, “the collection of beliefs, affects, and behavioural intentions a person holds regarding environmentally related activities or issues”, while Gallagher (2004, p.97) regarded environmental attitude as “perceptions of or beliefs regarding the physical environment, including factors affecting its quality”. At the same time, an increasing number of people around the world are expressing concerns over environmental issues and restoring the natural environment (Swami et al., 2010). The term *environmental concern* (EC) is associated with environmental attitude and is sometimes used to refer to it (Dunlap & Jones, 2002; Fransson & Gärling, 1999), although a study by Bamberg (2003) concluded that environmental concern, as

an effect, seems to be part of a general environmental attitude. Schultz et al. (2005; 2004) support this conclusion.

3.1.1 Theoretical approaches to environmental behaviour

A popular social-psychological theory for explaining behavioural choices is Ajzen's (1991) theory of planned behaviour (TPB) (De Groot & Steg, 2007; Wall et al., 2008). The theory, developed from the theory of reasoned action (Ajzen & Fishbein, 1980), assumes that human action is guided by three kinds of situation-specific beliefs: beliefs about the possible consequences of the behaviour (behavioural beliefs), beliefs about the normative expectations of other people (normative beliefs), and beliefs about the presence of factors that may facilitate or hinder performance of the behaviour (control beliefs) (Ajzen, 1991, p.179). In their respective aggregates, behavioural beliefs result in *attitudes* favourable or unfavourable to the behaviour in question, and normative beliefs outline the perceived *subjective norms* in relation to other people, while control beliefs define the *perceived behavioural control*, the perceived ease or difficulty of performing that specific behaviour (Figure 3.1).

Figure 3.1 Theory of planned behaviour (TPB) (Adapted from: Ajzen, 1991).

According to Ajzen (1991), the combination of attitudes towards behaviour, subjective norms, and perceived behavioural control, lead to the formation of behavioural *intention* to perform a given behaviour. Intention is assumed to be the

immediate originator of behaviour, however because many behaviours cause difficulties when it comes to their execution that may limit the will to act, TPB implies considering perceived behavioural control in addition to intention as the main predictors of actual behaviour (Ajzen, 1991, p.179). Due to the fact that people are realistic in their judgments of difficulty related to behaviour, a measure of perceived behavioural control can serve as an alternative for actual control and contribute to the prediction of the behaviour in question (Ajzen, 1991, pp.181, 182). A number of studies have confirmed the usefulness of this theoretical model in predicting pro-environmental behaviour (Bamberg & Möser, 2007; Stern, 2005; Kaiser et al., 1999). Conversely, Blamey (1998) observed that the TPB is less focused on the process by which individuals decide to take a course of action (such as recycling) since it is primarily concerned with the identification of the individual's perceptive and normative beliefs that influence pro-environmental intention, and this implies that individuals would give up self-interest (the inconvenience of recycling) for the benefit of the community (producing less waste) (Thøgersen, 2006). Consequently, the theory would not specify the likely purposes of the essential beliefs, as it would probably not be specific to altruistic or cooperative behaviour.

Figure 3.2 Norm-Activation Theory (Adapted from Wall et al., 2008)

Another theory that has dominated social-psychological research on environmentally significant behaviour is Schwartz's (1977) norm-activation theory (NAT) (Wall et al., 2008) (Figure 3.2). NAT explains altruistically motivated behaviour and maintains firstly that behaviour is a function of people's

acknowledgment of responsibility for their action, and secondly of people's awareness that their actions might have consequences that could affect the welfare of others, including consideration for non-human species and the biosphere (Stern et al., 1999). The theory suggests that although some individuals might expect personal gain on egoistic grounds, most would also be motivated by a broader altruistic concern (Wall et al., 2008). NAT considers awareness of adverse consequences and beliefs about personal obligation encourage an ascribed responsibility construct, which in turn activates a *personal norm* in order to perform the behaviour (Blamey, 1998; Wall et al., 2008). Schwartz also argued that *awareness of consequences* and *feelings of responsibility* would moderate the influence of personal norm on behaviour (Figure 3.2).

Stern et al. (1999) proposed that a combination of values, beliefs, and personal norms is central to supporting environmental attitudes and would drive individuals to act in support of individual and common objectives. This extends Schwartz's norm-activation theory to develop a value-basis theory for understanding environmental attitudes. The theory emphasises awareness of the adverse consequences (AC) of events highlighting three types: awareness of egoistic, social-altruistic, and biospheric consequences, these being the values that can establish environmental attitudes (Stern et al., 1999).

As Ajzen's theory of planned behaviour and Schwartz norm-activation theory, as well as its extension, are typically used to predict ecological behaviour, these will be important frameworks for understanding environmental behaviour in this research.

3.1.2 Environmental concerns

In the field of psychology, the significance of research into individual's concerns for preserving or improving the natural environment has increased (Swami et al., 2010; Schultz, 2000; Bamberg, 2003), reflecting evidence of ongoing trends in population growth (Meadows et al., 1972; Meadows et al., 2004, pp. 24–36; Turner, 2008; Ehrlich, 2010) combined with material growth and

environmentally harmful consumption behaviour (Meadows et al, 2004, pp. 24–36; Eastin et al., 2011; Randers, 2012a; Fudge & Rowe, 2001).

Environmental concerns have been discussed as an evaluation of the consequences of the behaviour of a person or group, and their attitudes towards facts concerning the environment (Fransson & Gärling, 1999). This has been described as “the degree to which people are aware of problems regarding the environment and support efforts to solve them and/or indicate a willingness to contribute personally to their solution” (Milfont, 2007, p.11, referencing Dunlap & Michelson, 2002).

More recently, the value-belief-norm (VBN) theory has become the dominant paradigm for understanding environmental concerns. This is an extension of Schwartz’s (1977) NAT of altruistic behaviour, Stern and Dietz’s (1994) value-basis theory for environmental concerns, and the later work of Stern et al. (1995b) in this area (Schultz, 2000; Schultz, 2001; Snelgar, 2006; Stern et al., 1999). The focus of VBN theory is on clusters of *valued objects* rather than on *values* as such (Schultz, 2000). The theory assumes three value cluster orientations: *egoistic* (concern for the self in relation to the environment), *altruistic* (concern for other people in relation to the environment), and *biospheric* (concern for the biosphere, including plants, marine life, birds, animals) (Figure 3.3). Pro-environmental behaviour is predicated on the basis of these values, and that awareness of AC, for particular valued objects, will activate personal norms, which in turn will motivate pro-environmental behaviours (Schultz, 2001).

Figure 3.3 VBN Theory, three orientations to environmental concern.

In the TPB, Ajzen (1991) proposed that attitude would influence a given behaviour, mediated by intention to perform it. Kaiser et al. (1999) felt factual knowledge was a prerequisite of any attitude and that the relationship between factual knowledge and behaviour is mediated by intention. In addition, subject norms are also mediated by intention and therefore indirectly predict behaviour (Figure 3.4).

To extend the TPB to a consideration of environmental behaviour the model has to consist of factual knowledge about the environment, social and moral values on the environmental, and social behavioural intention (Kaiser et al., 1999).

Figure 3.4 Kaiser et al.'s version of the theory of planned behaviour (Kaiser et al., 1999).

3.1.3 Determinants of environmental concerns

A number of studies have investigated the relationships between socio-demographic influences and attitudes towards the environment (Fransson & Gärling, 1999; Schultz, 2001; Snelgar, 2006; Swami et al., 2010). Parameters include the associations between environmental concerns (ECs) and a person's age, political orientation, gender, and education.

In relation to age, younger individuals are assumed to be more concerned about environmental deterioration than older people. This could come about from the observation that young individuals are less integrated into the existing social order

(Fransson & Gärling, 1999; Swami et al., 2010). However, the proportion of concerned older individuals has also been increasing, as observed from their quest for information on environmental issues and the effects on them of media campaigns about the environment (Fransson & Gärling, 1999). Slimak and Dietz (2006) supported this, finding that age had no consistent relationship with concerns about environmental risks.

For political affiliation it seems environmentally concerned individuals tend to be liberal, as more right-wing individuals show lower ECs (Swami et al., 2010). This view is supported by Fransson & Gärling (1999, referencing Dunlap, 1975) who noted that business and industry normally support conservative ideologies, and that environmental development would require extending government activities and regulations as well as involving innovative actions, which conservatives tend to oppose. Several studies have found a positive correlation between education and ECs (Fransson & Gärling, 1999; Dunlap, 2008; Olli et al., 2001; Hines et al., 1986/87).

Schultz (2001) found evidence that women have higher scores for all three-value orientations. Swami et al. (2010) found higher scores in altruistic and egoistic concerns for women than men. They also referred to a previous study by Zelezny, Chua, and Aldrich (2000) where, across 14 countries, women were more likely than men to show pro-environmental behaviour. This was attributed to women's greater social responsibility and empathy towards others (Swami et al., 2010). There is still debate over ECs and gender. Although both Snelgar and Swami found that women were more likely than men to show pro-environmental behaviour (Snelgar, 2006; Swami et al., 2010), Snelgar also reported gender was a very weak predictor of ECs.

Schultz's study (2001) also correlated environmental concerns with individual differences, finding egoistic concerns were positively correlated with self-enhancement (enhancing an individual's own personal interest) and negatively correlated with self-transcendence (transcending an individual's selfish concerns

and contributing to the well-being of others). The opposite pattern of correlations was reported for biospheric concerns, which were negatively correlated with self-enhancement and positively correlated with self-transcendence. Altruistic concerns showed similar correlations to biospheric concerns, in that they were negatively correlated with self-enhancement and positively correlated with self-transcendence.

In relation to place of residence, individuals who live in urban areas seem to be more environmentally concerned than those in rural areas. This could be due to their exposure to signs of environmental deterioration (Fransson & Gärling, 1999).

3.1.4 Personality and environmental concerns

The Big-Five classification of personality traits is another individual difference predictor of ECs. It describes variation in human personality across five broad domains (Goldberg, 1993). The framework has become a widely used and extensively researched model of personality (Gosling et al., 2003; Hirsh, 2010). It is hierarchical with five broad factors representing personality at its widest level of abstraction. The framework suggests that most individual differences in personality can be classified into five domains: *agreeableness*, *conscientiousness*, *emotional stability*, *openness*, and *extraversion*. Each bipolar factor summarizes several more specific inventories, which include a large number of even more specific traits (Swami et al., 2010 referencing McCrae & Costa, 1997; Gosling et al., 2003). Two of these traits, agreeableness and openness, are significant predictors of pro-environmental values as they relate to higher levels of empathy and self-transcendence (Hirsh, 2010).

Swami et al. (2010) examined the relationships between the Big-Five traits and the three-factor model of ECs. They found a lack of significant association between the Big-Five personality traits and egoistic concerns as none of the traits measure selfishness in any detail. However, these factors were most effective at

predicting biospheric concerns. In contrast, there is a lack of significant association between the Big-Five and altruistic concerns.

3.2 Environmental attitude and ecological behaviour

Environmental attitude is considered one of the most promising concepts behind moving an individual's behaviour in a more ecological direction (Newhouse, 1990). In general, attitude is defined as an enduring positive or negative feeling about some person, object, or issue (Newhouse, 1990). Hines et al. (1986/87) recognised two types of environmental attitudes that could predict ecological behaviour. These were attitudes toward the environment, and attitudes toward ecological behaviour. The former usually refers to environmental concerns (Vining & Ebreo, 1992).

Milfont (2007, p.21) described four functions of environmental attitudes. The first is having an evaluative tendency to respond to perceptions of or beliefs concerning the natural environment. Secondly they are based on a scale or inventory with no defined benchmark measures. Thirdly they can be broken down into the cognitive, influential, and behavioural components from which environmental attitudes are derived. Finally, they serve several functions.

3.2.1 Environmental concerns measure

Schultz (2001) affirmed international survey findings that listed environmental problems as primary among social problems and that increasing numbers of people worldwide are voicing concerns about environmental issues. Building on the concept of valued objects in the VBN theory and his earlier research findings in 2000, he suggested that individual's perceptions of the interconnection between themselves and other people (altruistic) or between themselves and nature (biospheric) would determine the type of concerns they would develop towards the environment (Schultz, 2000). These findings along with those from other studies (Stern & Dietz, 1994; Stern et al., 1995a; Stern et al., 1995b) provide strong evidence for making the distinction between egoistic, altruistic and biospheric environmental concerns (Schultz, 2001). From this, Schultz identified

three clusters that form the basis for the classification of ECs. Concerns for environmental damage are organized around self (my health, my future, my lifestyle, me), other people (people in my community, all people, children, my children), and the biosphere (plants, animals, marine life, birds) (Schultz, 2001). This became a research model for related studies such as those of Schultz (2001), Snelgar (2006), De Groot & Steg (2007), Hirsh (2010), and Swami et al. (2010). Based on the EC scale, in which several objects for each value orientation are rated for importance in relation to environmental issues, Schultz (2001) demonstrated that a three-factor model of egoistic, altruistic, and biospheric ECs fitted the data better than either single-dimensional or two-factor models (Schultz, 2001), a conclusion supported by Snelgar (2006) and Swami et al. (2010).

Schultz (2000) also suggested, “any activity that reduces an individual’s perceived separation from nature will lead to an increase in that individual’s biospheric concerns.” In a later study, Schultz (2001) reported a positive correlation between interconnectedness of self and nature (the overlapping of self-schemas with those of other living things) and biospheric concerns. Swami et al. (2010) found in a more recent study that where individuals view themselves as interconnected with all living things this is a predictor of biospheric concerns, whereas differentiating themselves from others and focusing on their unique attributes predicts egoistic concerns. So, individuals with a greater connection or empathy with the natural world, or who feel less separate from it, tend to have higher biospheric concerns and lower egoistic concerns.

3.2.2 Awareness of adverse consequences measure

Schwartz’ norm-activation model (1977) states that intentions to perform a behaviour are a function of both ascriptions of personal responsibility and awareness of adverse consequences (AC) (Milfont, 2007, p.25). The model explains helping behaviour towards other people results from social and personal norms, AC for the environment, and assignment of responsibility to the self (Snelgar, 2006). From a social perspective, environmental issues can be

understood as social dilemmas because they can represent a conflict between the personal interests of an individual and the collective interest of a society (Milfont, 2007).

In the VBN theory (see Section 3.1.2), the determinants of intentions to perform pro-environmental behaviours include ACs, explained as individuals' beliefs about the adverse consequences of environmental problems producing a feeling of moral obligation to act pro-environmentally (Steg et al., 2005). This suggests an assigned responsibility to perform the behaviours that in turn activate a personal norm or moral obligation to perform them (Hansla et al., 2008).

Within the context of Stern et al.'s (1993) norm-activation model of pro-environmental behaviour, which is extended from the original model of Schwartz (1997), Joireman et al. (2001) developed a framework for integrating social value orientation and consideration of future consequences. The framework uses past and intended involvement in pro-environmental behaviour as the primary outcome variables relating to pro-self and pro-social environmental intentions, as well as to a strong belief in the social consequences of environmental conditions. Hence, Joireman et al.'s (2001) framework includes a number of value orientations from five environmental aspects. These are perceived biospheric consequences (4 items), perceived egoistic consequences (4 items), perceived social consequences (5 items), pro-environmental intentions (5 items), and pro-environmental behaviour (6 items). Hansla et al. (2008) state that AC beliefs are causally related to value orientation. As a result, these influence individuals to select and believe in information congruent with their value orientation and to deny incongruent information.

Joireman et al. (2001) found individuals showing egoistic and social AC express stronger pro-environmental intentions and a stronger belief in the social consequences of environmental conditions. This was supported by Hansla et al. (2008). In addition, individuals with stronger consideration for future consequences express stronger pro-environmental intentions, have greater

involvement in pro-environmental behaviour, and have a stronger belief in the personal, social, and biospheric consequences of environmental conditions (Steg, 2003; Joireman et al., 2001).

3.2.3 New Ecological Paradigm scale

On the issue of how individuals perceive themselves and their sense of connection with nature, Dunlap and Van Liere (1978, p.17) proposed the New Environmental Paradigm (NEP) as an emerging measure of living in harmony with nature, on the assumption people are an integral part of it. The research developed a scale that became widely used to measure pro-environmental orientation. Dunlap et al. (2000) later developed a revised scale in terms of widening the range of facets and improving the terminology. Further research proceeded to examine correlates of NEP, particularly attitudes and behaviour (Dunlap et al., 2000; Dunlap, 2008; Schultz, 2000).

NEP focuses on the role of environmental concern assuming that a person's environmental behaviour results from his or her worldview (Steg et al., 2005). It was developed to assess a proposed set of environmental behaviour results from general beliefs about the relationship between human beings and the environment, including the notion that societies are upsetting the balance of nature, the reality of limits to growth, and the need to shed an anthropometric orientation towards nature (Dunlap & van Liere, 1978, Dunlap et al., 2000; Amburgey & Thoman, 2012). Although NEP measures of environmental concern have been widely used the scales included items on specific environmental topics that have become dated as new issues have emerged, (Dunlap et al., 2000; Milfont, 2007; Hawcroft & Milfont, 2010). The broad appeal of the scale has also received criticism on psychometric grounds (Amburgey & Thoman, 2012). In response, the scale's founders revised and updated several aspects of the measure, simultaneously refining it and grounding the scale in contemporary attitude theory (Amburgey & Thoman, 2012).

Along with expanding the theoretical and conceptual reaches of their measure,

Dunlap et al. (2000) gave the scale new terms, and it is now referred to as the *New Ecological Paradigm* (Amburgey & Thoman, 2012). The revised NEP scale has a set of 15 items (8 pro-trait and 7 con-trait), with three items for each of five hypothesized facets of an ecological worldview. These are the reality of limits to growth; antianthropocentrism; the fragility of nature's balance; rejection of exemptionalism; and the possibility of an eco-crisis (Dunlap et al., 2000).

3.3 Environmental education

In an article defining environmental education, Stapp (1969) outlined the major objectives of such education as those that help individuals acquire a clear understanding that human beings are an inseparable part of a system that also consists of culture and the environment. Other objectives were a broad knowledge of the environment and its role in contemporary society, a fundamental understanding of environmental problems and how these might be solved, including the responsibility of individuals and society to help solve them, and attitudes of concern for the quality of the environment that might motivate people to participate in environmental problem solving. UNESCO (2014) stated that environmental education is vital in teaching society respect for nature and in enhancing public environmental awareness. Environmental education focuses on enhancing people's appreciation of the environment resulting in change towards pro-environmental behaviour (Bamberg & Möser, 2007; Wals et al., 2014), in order to modify human decision-making about environmental issues in culturally productive ways (Hungerford et al., 2000). However, there is no simple linear relationship between knowledge, awareness, attitude, and environmental behaviour (Kollmass & Agyman, 2002; Kaiser et al., 1999; Wals et al., 2014).

3.3.1 Pro-environmental behaviour

In 1986/87 Hines et al. published an important meta-analysis of behaviour research literature linked to environmental education. The analysis produced a number of major categories of variables associated with pro-environmental behaviour. The study also analysed the association between pro-environmental behaviour and the four psychological variables of attitude, locus of control (self-

efficacy), moral responsibility, and behavioural intention. It affirmed the duty of the school system to develop and implement approaches to address affective and cognitive experiences and provide individuals with the skills and practices necessary for environmental action (Hines et al., 1986/87). This view was supported by Hungerford & Volk (1990), Ramsey (1993), and Butterworth & Fisher (2000). Hines et al. (1986/87) proposed a model of environmental behaviour that considered the *intentions to act* and *situational factors* (external influences such as other people and the environment) as direct determinants of pro-environmental behaviour. The idea of intentions to act was viewed as summarising the relationship between cognitive skills (action skills, knowledge of action strategies and knowledge of issues) and personality factors (attitude, locus of control and personal responsibility) (Figure 3.5). In addition, they considered the influence of circumstantial factors, such as economic conditions, social pressure, and opportunities to choose difficult action paths, as these might influence both going against or for the variables in the model.

Figure 3.5 Model of responsible environmental behaviour. It considers intentions to act and situational factors as direct determinants of pro-environmental behaviour
(Adopted from: Hines et al., 1986/87)

In relation to this, Bell (2005, pp.50–51) proposed a process of environmental thinking and action in environmental learning suggesting a notion of five environmental *moments* of sensible action. These are conceptualising the

environment, concerning sensibility about environmental issues or problems; knowing about the environment, related to acquisition of new knowledge for environmental decision making; knowing how to respond, in terms of moral and ethical knowledge in order to make a suitable response to the environment; responding, in relation to having motives and values about the environment but not acting on them; and finally acting, involving changing behaviour. Through exposure to this process, the community would progress through all five environmental moments of environmental sense making and action in order to arrive at changed behaviour practices towards environmental issues.

Based on the study of Hines et al. (1986/87), Hungerford and Volk (1990) attempted to address the effectiveness of environmental education for the promotion of responsible citizenship behaviour. Their study challenged traditional thinking that behaviour can be changed by making individuals more knowledgeable about the environment and its associated issues. Interestingly, in Figure 3.5, knowing how to change is seen as being as important as knowledge about the environment.

Hungerford and Volk (1990) concluded that there are a variety of variables associated with human behaviour that appear to fall into the three main categories of entry level, ownership, and empowerment variables. Within these some variables are identified as major and others as minor, although all variables probably operate in some sort of synergistic manner. *Entry level variables* appear to be related to pro-environmental behaviour within which 'environmental sensitivity' (having an empathetic perspective towards the environment) is a major variable and 'knowledge of ecology', 'androgyny' (reflecting non-traditional sex-role action characteristics) and 'knowledge of ecology' are minor variables. *Ownership variables* are concerned with the individual *owning* the issue. Ownership variables are critical for pro-environmental behaviour where 'in-depth knowledge about issues' and 'personal investment in issues and the environment' are considered major variables, while 'knowledge of the consequences of behaviour' and 'a personal commitment to issue resolution' are

minor variables. Finally, in relation to *empowerment variables*, which seem to be crucial in environmental education, the major variables are ‘knowledge of and skill in using environmental action strategies’, ‘locus of control’ (referring to an individual’s belief in being reinforced for a certain behaviour), and ‘intention to act’, and the minor variables include ‘in-depth knowledge about issues’ (Figure 3.6). While entry level category variables appear to be pre-requisite for enhancing an individual’s decision making and are to do with solutions to issues, ownership category variables make environmental issues personal, denoting that the individual owns the issue. Empowerment category variables, on the other hand, are crucial in giving individuals a sense that they are able to initiate and influence changes that help resolve important environmental issues.

Figure 3.6 Environmental behaviour model displaying major and minor variables involved in pro-environmental behaviour. (Adapted from: Hungerford and Volk, 1990)

Hungerford and Volk (1990) suggested that, in contrast with typical education practice, awareness does not lead to behaviour change in the environmental dimension. Therefore, environmental education, being issue related, must focus beyond environmental sensitivity, ecological foundation, and issue awareness. If environmental issues are to become part of instructions designed to change behaviour, these must give learners the opportunity to develop a sense of *ownership*

and *empowerment* so they are prompted to become responsible and active citizens. Ownership tends to come with being allowed to bring about change in an environment. Thus having children grow vegetables at school will be more likely to make children into gardeners than learning about why growing food at home maybe important for the environment. Hence, Fien (1993) and Strife (2010) have called for more socially critical approaches that emphasise empowering students, individually and collectively, to become environmentally responsible citizens. According to Strife (2010), a number of countries, among them Australia, New Zealand, Germany and the UK, have reoriented environmental education to focus attention on the social and economic aspects of environmental problems. The term *education for sustainability* is now preferred to *environmental education* because education for sustainability suggests alternative ways of thinking about the economy, environment, society and education (Huckle, 1999).

Twenty years after Hines et al. (1986/87), Bamberg and Möser (2007) published a paper replicating and extending the earlier meta-analysis of environmental behaviour to include psychosocial theories analysing the interaction of knowledge, behavioural constraints and opportunities, as well as personal values and motives in influencing the decision to behave in a pro-environmental way. They view pro-environmental behaviour as a mixture of self-interest (egoistic), concern for other people and the next generation (altruistic), and concern for other species and the whole eco-system (biospheric). These are reflected in the theoretical models most frequently applied in explaining pro-environmental behaviour. They also pointed out that although a considerable number of studies have analysed the role of variables as behavioural predictors, such as problem awareness and knowledge, attitude, perceived behaviour control, social norm, and intention, the number of studies including *moral* feelings such as guilt or shame as predictors is considerably lower. The results of two studies (Manstead, 2000; Bamberg & Möser, 2007) show that activation of the moral norm¹, instead of the social norm, as a determinant of intention, is determined by the interaction

¹ Moral norms are defined as rules that society has agreed upon for the sake and betterment of the community as a whole (Harms & Skyrms, 2007).

between cognitive, emotional, and social factors. The results also reveal the social norm to be a more indirect determinant of intention, associating it with the moral norm through its association with feelings of guilt, perceived degree of behavioural control, and attitude. Hence the results support the idea of pro-environmental behaviour as a mixture of self-interest and pro-social motives. Consequently, both motives, self-interest and morality, need to be taken into account in understanding pro-environmental behaviour.

Markowitz et al. (2012) described pro-environmental individuals in terms of behavioural constructs as more likely to be female, younger, financially comfortable, and with a good environmental knowledge, based on earlier work by Hines et al., (1986/87), Kalof et al. (2002), (Thøgersen & Olander, 2006), Snelgar (2006), and Swami et al. (2010). Those more likely to hold positive environmental attitude are more likely to be well informed about the consequences of their actions (Frick et al., 2004), and express concern about the well-being of the natural world (Bamberg & Möser, 2007).

3.3.2 Environmental behaviour: actions and barriers

Pro-environmental behaviour simply means “behaviour that consciously seeks to minimise the negative impact of one’s actions on the natural and built world” (Kollmuss & Agyeman, 2002). However, there is a gap between holding environmental knowledge and ecological awareness, and displaying pro-environmental behaviour (Markowitz et al., 2012, p.82). In order to explain the influences of and barriers to pro-environmental behaviour, Kollmuss and Agyenam (2002) developed a model that demonstrates the complex relationships between the different factors that influence pro-environmental behaviour and those that can affect it, positively or negatively. These include external factors, such as institutional, economic, social, and cultural factors, and internal factors, such as motivation, environmental knowledge, awareness, values, attitudes, emotion, locus of control, responsibilities, and properties. These competing factors shape people’s daily decisions and actions (Kollmuss and Agyeman, 2002). Their research found no direct relationship between possessing environmental

knowledge and pro-environmental behaviour explaining that reliance solely on information to drive change in behaviour is not valid. This supports the earlier findings of Hungerford and Volk (1990). Kollmuss and Agyeman (2002) supported a long period of environmental education as they saw environmental knowledge, values, and attitude, together with emotional involvement, as making up a complex they called *pro-environmental consciousness*. This in turn is embedded in broader personal values and shaped by personality traits and other internal and external factors. In terms of personality traits, pro-environmental individuals are found to be relatively high in openness to experience but are not different from others in altruism-related personality traits (Markowitz et al., 2012).

Gifford (2011) later outlined seven psychological barriers to behaviour change as being important factors affecting and hindering people's engagement in sustainable behaviour. He called these the *dragons of inaction* and these are set out below.

- (1) Limited cognition about the problem such as, ignorance, ancient brain, environmental numbness, uncertainty, optimism bias, and perceived behavioural control/ self-efficacy;
- (2) ideological worldview that tends to preclude pro-environmental attitudes and behaviour, such as superhuman powers, techno-salvation, and system justification;
- (3) comparisons with other key people such as social comparison, social norms and networks, and perceived inequity;
- (4) sunk costs and behavioural momentum, such as financial investments, and conflicting values, goals, and aspirations;
- (5) dis-credence toward experts and authorities, such as mistrust, perceived programme inadequacy, denial, and reactance;
- (6) perceived risk of change, such as functional, physical, financial, psychological, and temporal; and
- (7) positive but inadequate behaviour change, such as ineffective environmental actions (tokenism) and rebound effect.

On another note, social factors shape the development of an individual's values (egoistic, altruistic, or biospheric), which in turn guide the development of a belief system and form views of the world. These represent an environmental awareness and knowledge base from which new attitudes and beliefs about environmental issues are formulated, which in turn might influence intentions and commitment to pro-environmental behaviour (Stern, et al., 1995b). Social norms are often considered potential influences for progress in environmental issues, but they can also be influences for regression (Gifford, 2011). Social networks in communities and workplaces can also be positive or negative influences. In a particular case, community discussions and dwelling proximity combined to clarify why 7 out of 44 residences (16%) chose to install PV panels on their houses, far above the national average of 1% (Gifford, 2011).

Figure 3.7 Kollmuss and Agyman's model for pro-environmental behaviour (Adapted from Kollmuss and Agyman, 2002).

In their model for pro-environmental behaviour (Figure 3.7), Kollmuss and Agyman (2002) placed social and cultural factors in the group of external factors,

even though these might be seen as separate categories overlapping with internal and external factors. Economic factors were also intertwined with social, infrastructural, and psychological factors. They considered economic factors important when designing new policies and strategies that are meant to influence people's behaviour, but predicting people's behaviour purely on economic grounds would not reveal the whole picture.

The model of Kollmus and Agyman (2002) illustrates how the different factors influence each other and, ultimately, pro-environmental behaviour. The biggest positive influence on the latter, indicated by the thicker arrow, is achieved when internal and external factors act in synergy. On the other hand, the green boxes indicate possible barriers to positive influence on pro-environmental behaviour. Kollmuss and Agyeman (2002) affirmed that old behaviour patterns are the biggest barrier to positive influence on pro-environmental behaviour, and this is often overlooked in research in this area. People might be perfectly willing to change their behaviour but still fail to do so because they do not persist enough in practicing the new behaviour until it has become a habit. Other big barriers are people's desire for comfort and convenience.

Finally, Kollmuss and Agyeman (2002) insist that human feelings of responsibility are shaped by personal values and attitudes and are influenced by the locus of control. The priority for most people is their well-being and the well-being of their family. So when pro-environmental behaviours are aligned with these personal priorities, the motivation to do them increases. If they contradict the priorities, pro-environmental action is less likely.

3.4 Design processes for behaviour change

In discussing the visions and methods that *research through design* brings, Manzini (2009) wrote, "Design is a discipline that combines creativity and subjectivity with a dose of reflection and arguments on its own choices". Conversely, in terms of purpose, design research is an activity that aims to produce knowledge and processes useful to those who design. So, in the face of current environmental and

social problems and for making the transition towards sustainability in society through design, a sense of realism and optimism when problem solving is required. Currently, in the development of *design for behavioural change* as a field of study, the majority of academic work, particularly in product design, is focused on exploring the possible interventions and ways designers can apply ideas related to behaviour (Boks, 2011; Wilson et al., 2013; Bhamra et al., 2011). Planning for interventions that steer user behaviour towards more environmentally conscious actions may involve adopting and adapting principles from other fields that have established methods for investigating issues related to behaviour change. The majority of principles, insights, and approaches have come from social and environmental psychology and allied fields (see Sections 3.2 and 3.3) (Bhamra et al., 2008; Lilley, 2009; Lockton et al., 2013; Kuijer & de Jong, 2011; Thorpe, 2010).

3.4.1 Design research and sustainability

In his introductory paper at an international conference on the role and potential of design research in the transition towards sustainability, Manzini (2009) stated that given current global environmental problems, working towards change for a designer would be based on two main ideas. The first is for change through working towards a network and knowledge-based society re-oriented towards sustainability and the second is for the design community to play a positive role in this re-orientation through building new design knowledge. The designers' role would involve a contribution to and integration of all the relevant systems, these being environmental, social, economic, and even aesthetic. Thorpe (2010) agrees on the significant role of design, but goes further and states that product researchers exploring environmental policy tend to see design as the heart of the problem, referencing statistics that show 90% of the environmental impact of a product could be fixed at the design stage.

Manzini (2009) further maintained that design research could not be separated from the purpose and social significance of its results. Hence as an activity it should aim to produce knowledge useful to others. Accordingly, the nature and

quality of design research could move from a discussion of methods to producing results and knowledge useful to designers and non-designers, including individuals, communities, institutions, and companies. Furthermore, as design research aspires to produce visions and proposals, it would usually adopt original methods, using tools and skills suitable for the designer's culture and practice, and hence would combine creativity and subjectivity with reflection and reasoning (Boks, 2011; Manzini, 2009).

Bhamra et al. (2008) adopted the approach of design for behaviour change as a means of editing design choices, leading to a product that displays environmental knowledge, thus enabling users to act upon this. Design for sustainable behaviour is an emerging research area, stemming from the fields of sustainable design and interactive design. It applies concepts from multiple disciplines to the challenge of influencing pro-environmental behaviour in the use of products and environments (Bhamra et al., 2008; Elias et al., 2007; Lilley et al., 2005; Lilley, 2009). As an example, Elias et al. (2007) conducted a study of user behaviour and energy efficiency in operating appliances in six households in the UK in order to select those that were most environmentally harmful but also most likely to benefit from a new user-centred design approach. They singled out the kitchen as having the highest energy using appliances as well as being the centre of household activities during the day. A video camera was set to record members of the household using various kitchen appliances. The actions of the kitchen users were logged against a time line with a description of the activity and who was performing it. The results were used to obtain a comprehensive view of energy use in the household. Consequently, an extensive design stimulus for creating pro-environmental products and practice patterns, based on user behaviour and desired function, was created.

3.4.2 Design processes for environmental sustainability

In order to create a framework for economic interests and systemic resource optimisation, potentially aiming for sustainability in product design and development, Manzini and Vezzoli (2003; 2002) introduced the concept of

strategic design for sustainability. This would be a shift from the usual focus on the physical result of a design process to a *system focus* where the physical result would be an “integrated whole of mutually dependent products and services, jointly capable of meeting and satisfying specific users’ demands, including their sustainable requirements” (Manzini & Vezzoli, 2002). This would entail accounting for the life-cycle of products and services, achieving a set of specific demands for the users, and providing enabling platforms for the users of the physical result, possibly via a digital interface (Manzini & Vezzoli, 2003; Manzini & Vezzoli, 2002). The authors acknowledge that although the strategic design approach could change consumer behaviour, it would not necessarily lead to sustainable solutions as “society as a whole is a set of complex, inter-related systems that are not clearly understood” (Manzini & Vezzoli, 2003).

Manzini and Vezzoli (2003) analysed examples from an environmental innovation Italian competition and established a general framework model for describing eco-efficient potential. In that model, the systems approach would be achieved in levels (Figure 3.8). These shifted from discrete phase-based optimization, i.e., the traditional market of a range of operators (raw material suppliers, producers, retailers, consumers, and end-of-life managers) who tend to optimise their ‘segment’ of the process (see inner arrows of Figure 3.8), to product life-cycle function-based optimization (the intermediate arrows of Figure 3.8), and then to satisfaction/solution wide system based optimisation (the outer arrows of Figure 3.8). The character of the strategic design system is an innovation that is not only based on technical products, but also on the way these products and technologies have been systematised to achieve an integrated solution, including overall systematic resource optimisation for eco-efficiency. The social and cultural factors influence the acceptance of such approaches as part of a satisfaction based system.

Figure 3.8 Operators in a products and services life-cycle mix; from discrete to life-cycle to satisfaction system resources optimization. Source: Manzini & Vezzoli, 2003.

Building design can adopt aspects of the strategic design for sustainability approach in integrating the various building elements and systems in a holistic way. This could produce a design discipline that introduces strategic design for sustainability where the intended design activity is aimed at developing an integrated system of elements, systems, and communications coherent with sustainability perspectives, while at the same time being economically feasible and socially responsive.

McDonough & Braungart (2003) examined the cradle-to-cradle design approach for architecture and the building industry in order to create healthy and restorative buildings and settlements. The main idea was to try to eliminate waste rather than reduce it. Thus, everything would be able to be broken down into technical or biological nutrition that could be reused so no waste would be created and there would be no need to dispose of waste products. Accordingly, materials and systems would be designed to mirror the earth's cradle-to-cradle cycles as *nutrients* circulating through the system in a closed-loop cycle of production, recovery, and remanufacture (Figure 3.9).

Figure 3.9 Nature's nutrient cycles compared to technical nutrients cycle.

Source: McDonough & Braungart, 2003.

The authors gave the use of geopolymers as building materials made from earth and high quality plastics as an example of such an approach. These are far more stable than concrete and require far less energy to produce. Design for disassembly would allow building materials made of geopolymers to be used again in new buildings. McDonough applied the same principle in the design of the Adam Joseph Lewis Centre at Oberlin College in Ohio. Completed in 2000, it was planned to develop healthy and interactive relationships with the natural world. The building was powered and lit by solar energy, its wastewater was purified and reused, the carpet could be retrieved and remanufactured as new high quality carpet, and even the upholstery fabrics could be used to feed the garden, thereby confirming the building's design as an integrated and organic system (McDonough & Braungart, 2003).

Chapman (2009) stated that for sustainable design to be truthful, it must seek to inspire new purpose and value in the critical area of human ecology. He emphasised the importance of the *durable* as a design paradigm that extends beyond the product's life, from physical endurance to the emotionally durable characteristics within the product. His design strategy called for considering the emergent paradigm of *emotionally durable design* to produce a new type of product characterised by reducing consumption and waste through nourishing the resilience of relationships between consumer and product. He felt this would offer a holistic approach to design for durability and hence the live experience of sustainability. Chapman's holistic approach aligns with that of Manzini and Vozelli since it is characterised by a set of short-term strategies for sustainability.

These are ways of rethinking existing technologies beyond their conventional characteristics, the application of product optimization methods, and optimizing the relationships between user and product in a socio-cultural context.

3.4.3 Design and sustainable user behaviour

A number of recent studies have examined products and services explicitly intended to influence sustainable human behaviour, to ease environmental concerns, and to address other areas of social benefit (Lockton et al., 2013; Lockton et al., 2011; Bhamra et al., 2011; Bhamra et al., 2008; Lilley, 2009). Bhamra et al. (2011) stated, “Designers should be made aware of potential problems caused by user behaviour.” In that regard, their study observed a lack of user awareness of the link between personal behaviour and its impact on the environment or society. They also found the operating patterns and practices related to products and services are normally performed in a routine and habitual manner, and that the interaction of users with products exposed the ingrained cultural and social values that shape user consumption behaviour. Elias et al. (2009) shared this view in their study of the energy efficiency of products through calculating energy losses. They noted there are “two kinds of losses: intrinsic losses, determined by technology and materials used to construct the product, and user-related losses, which are caused by varying and inefficient use of that product by the user.”

However, the beginning of the 21st century has witnessed increasingly motivated designers who aim to influence the behaviour of society (Tromp et al., 2011; Wilson et al., 2013). This interest is seemingly manifested first in a more socially responsible attitude to product development, focusing on using recyclable materials, rejecting child labour, and using sheltered workshops, and secondly through applying *design thinking* and methodologies to social issues in order to create innovative solutions where education, safety, and health care are becoming dominant factors (Tromp et al., 2011).

In relation to pro-environmental behaviour, a number of studies on monitoring

the energy consumption of household products in residential buildings found energy consumption behaviour in the *operation phase* of the life-cycle of a product was a significant factor in overall energy use (Bhamra, et al, 2008; Lockton et al., 2013; Lockton et al., 2010; Wood & Newborough, 2002; McCalley & Midden, 2002; Dietz et al., 2009). In the UK, the domestic sector accounts for 30% of the country's energy demand (Elias et al., 2007), while energy use in domestic products formed over 13% of total domestic electricity use (Elias et al., 2009). In order to achieve reduced household energy use, Dietz et al. (2009) suggested adopting a near-term approach through using a number of behavioural interventions rather than long-term climate change policies. Their study concluded that if implemented nationally, this approach could save 20% of total US direct CO₂ emissions through behavioural change with little or no reduction in household living standards. With the aim of finding ways to increase energy conservation behaviour, further studies on household energy consumption in the UK and the Netherlands using focus groups (Wilson et al., 2013) have generated average energy savings of 15 and 21% respectively over the control group, by giving consumers immediate energy electronic feedback. Others have found feedback influences user behaviour decisions (Wood & Newborough, 2003; McCally & Midden, 2002). Wood and Newborough (2003) identified the importance of providing regular feedback to consumers during energy use. They also concluded that employing electronic feedback methods to customers resulted in an average reduction of 15% whereas those given an information pack alone reduced their energy consumption, on average, by only 3%. Another study suggested that by addressing design solutions through understanding user behaviour, a reduction in energy consumption of up to 30% might be achieved (Boks, 2011). Thus, sustainability is not just an energy and material issue, but also, and to a large extent, a behavioural one.

Aiming to help designers address sustainable behaviour in their product users and influence people's behaviour, Lockton et al. (2013) introduced their Design with Intent Toolkit software. This is an idea generation method to redesign everyday products, with the intention of reducing their environmental impact in operation.

The design of the kit was influenced by the concept of *design patterns* originally developed by Alexander et al. (1977), where rated patterns were essentially considered as recurring problem-solution instances covering the design and layout of buildings, towns, and communities.

3.4.4 The Hockerton Housing Project

The Hockerton Housing Project (HHP), 5 km north of Southwell, Nottinghamshire, is an example of a sustainable building project that was significant in influencing people's behaviour (Figure 3.10). It was the first attempt in the UK to build a zero-emission community (Vale & Vale, 2013, p.262). The first phase of the project consisted of a terrace of five single storey earth-sheltered dwellings in a rural setting where the families aimed to be self-sufficient in food, water, and energy. Completed in 1998, the dwellings were zero net fossil fuel through the use of operational energy savings through design and renewable energy generation, and harvested all water and disposed of all sewage on site. The project was also low carbon in terms of organic food grown on site, and through a community approach to work and transport (EST, 2003).

The people involved in the HHP were motivated to invest their own money in a low-environmental impact project. During the process of design and building, the group was able to withstand problems that arose on a number of occasions, an illustration being standing firm to overcome the initial resistance from the neighbours and territorial authorities to install the first of two wind turbines (Vale & Vale, 2013, p.262). Later in 2012, inspired by the success of the project, residents in the village of Hockerton decided to purchase and install a second-hand wind turbine in order to help lower carbon emissions in the local community, and that resulted in producing more electricity than the village consumes. This shows how certain values held in the community can lead and inspire action, motivating others to change values and initiate further projects in the same village to the benefit of all (Vale & Vale, 2013, pp.262–263). The Hockerton experience suggests that carefully planned and monitored demonstration projects can be an inspiration for attitude motivation.

Figure 3.10 The Hockerton Housing Project, Nottinghamshire.

Source: www.hockertonhousingproject.org.uk

The project's aims and principles have inspired the behaviour of its residents in a number of aspects. In terms of energy, the project relies on renewable wind and solar sources, where the energy generated equals the annual consumption, which helped lower the ecological footprint for energy used in the home and on site. The result was lower power bills (lines charges have to be paid) as well as providing assistance for some residents who generate income from working at home with lower power costs compared to working off site. This required a different way of calculating energy costs as it is based on renewable energy and falls outside the common business methods on which society is organized (Vale & Vale, 2013, p.264).

In reviewing some of the environmental considerations of the project, Vale and Vale's study (2013, pp.264, 265) compared the average HHP household ecological footprint with the UK average in four categories and found savings for those living in the project in all of them. The smallest savings were in food and the largest in goods and services. The other two categories were energy and housing.

HHP was designed to influence its residents' behaviour towards being careful with the use of resources. Vegetables and other food are grown on site with an emphasis on eating local and organic produce, and that reduced the food footprint. There was also a focus on recycling, reusing, and composting to minimise waste, so when it comes to using goods and services all households felt they were 'cautious consumers'. Being a group of dwellings may have guided

individual decisions towards sustainable living practices, showing the power of the group when it comes to behaviour change (Vale & Vale, 2013, pp.263–266, 271). Finally, under HHP conditions, each household was required to contribute around 300 hours a year towards on-site tasks or business, thereby further endorsing the idea of sustainable and community living (Vale & Vale, 2013, p.264).

3.4.5 Design approaches for sustainable behaviour

Architects and designers have long been engaged in influencing human behaviour through the design and construction of the environment in which people live and work. An early example of 1898 is Ebenezer Howard, who initiated the *garden city* as a movement where planned and self-contained towns were surrounded by *greenbelts* (Howard, 1902, pp. 32–35). Le Corbusier, through the design of the Villa Savoye at Poissy, completed in 1929, and which was a representation of his manifesto of the *five points* of a new architecture, also sought to influence behaviour through creating *clean spaces*, with the emphasis on the feeling of individual freedom. This resulted in the liberal use of freestanding columns, strip-window facades, and cantilevered floor slabs (Frampton, 2007, p.157). Alexander et al.'s (1977) *Pattern Language* created a structure derived from timeless entities he called *patterns*, which were places and architectural elements well used by people from many different cultures and backgrounds. This extensive study found the way people live is directly linked to the designed environment they inhabit (Alexander et al., 1977, p.xiv).

The arrangement of architectural elements can influence and control how a user experiences living space (Beale, 2007). “Designers often aspire to do more than simply create building that are new, functional, and attractive, they promise that a new environment will change behaviours and attitudes” (Marmot, 2002). However, within design research, behaviour intervention studies are not yet common (Lockton et al., 2013). In fact, as stated earlier, studies on behaviour theory, influencing pro-environmental behaviour, and fostering sustainable behaviour are more established in social and environmental psychology and allied fields. It is noticeable that environmentally related intervention studies were

once popular in the 1970s, at the time of the energy crisis, and then largely faded from view until the 2000s (Lockton et al., 2013; Lockton et al., 2010).

Lilley et al. (2005, 2006) introduced one of the first categorizations defining interventions for behaviour change through product design. Their categories included educational interventions aiming at encouraging people to behave more sustainably; technological interventions aiming at reducing the impact of the product's use; and product-led interventions to create a shift in behaviour initiated by the products. Figure 3.11 shows categories of intervention ranging from educational (consumer focused) to product-led (product focused). Their research found just consumer education and technological intervention were not sufficient to reduce the impact of product use. Instead the product-led category was found to be more effective, where the shift was initiated by products that affected behaviour. This led to helping reduce environmental impacts, encouraging social stability and equality, and not relying on mass consumption in pursuit of these goals. The product-led category comprises scripts and behaviour steering through meaning written instructions that encode the use intentions of the designer (Jelsma, 2006, p.223); *eco-feedback* to inform users of the impact of their behaviour; and *intelligent* products and systems where products could help guide the decision making of the users and avoid or block inappropriate user behaviour.

Figure 3.11 Sustainable behaviour interventions, design led approaches. These range from consumer focused to product focused. Source: Lilley et al., 2006.

Through investigating ways of creating new energy efficient products, Elias et al. (2009) found user-related energy losses from product use were more significant than intrinsic energy losses. They felt this significance is likely to increase as advanced engineering design and technology of new products are predicted to drive intrinsic losses to a *theoretical minimum*. Targeting a reduction in user-related energy losses, their investigation identified three strategies: improving consumer education, providing direct feedback, and using a user-centred Eco-Design approach. Adopting the first two strategies reported a 10% and a 5–15% reduction in energy usage respectively (Elias et al., 2009).

On the other hand, the user-centred Eco-Design approach (Elias et al., 2007) is a behaviour based method able to work within the territories of existing user behaviours, with the aim of changing these to the same extent as would be achieved with a new product. The same end function would be achieved but perhaps in a different manner, so creating a number of possibilities. They captured these possibilities in a matrix (Figure 3.12) in which *new products* and *old products* are combined with *new user behaviour* and *old user behaviour*, giving four possible strategies.

Figure 3.12 A decision matrix for deciding the most appropriate strategy for improving energy efficiency. Source: Elias et al., 2009, p.119.

In figure 3.12 square 1, represents the current situation from which an improvement in energy efficiency would mean moving to any of the other three.

Square 2, involves changing the behaviour of users through education and feedback while keeping existing products. Square 3, introduces the next generation of products, reducing intrinsic and user-related losses, but working with the existing boundaries of current behaviour. Finally, Square 4 introduces new products, designed to induce new behaviours in both intrinsic and user-related energy losses (Elias et al., 2009). The inclusion of *old*, namely existing or current products was a significant point, particularly with systems that are unlikely to be replaced quickly. Unlike electronic appliances, items in buildings such as heating systems and most structural elements and components have a long life. There is also the case where existing products are not necessarily inefficient technically but end up being used inefficiently (such as always boiling a full kettle rather than only the quantity of water needed).

The particular characteristics of the matrix in Figure 3.12 that are also present in Figure 3.11 involve considering technological and human change as two possible directions in an overall strategy to achieve behavioural change, considered either independently or together.

3.5 Experiences from demonstration projects

3.5.1 The iLEED House

The iLEED (integrated Low Energy and Environmental impact Design) House, believed to be Ireland's first Zero Energy house, is located near Mullingar a town in County Westmeath in Ireland. It was designed and built by technologist and energy specialist Patrick Daly, who moved in 2009 (Doyle, 2011). The demonstration house was an attempt to integrate ultra-low energy design and the environmental impacts of materials, exploring the threshold where ultra-low energy design permits a shift and transition to low impact materials, including those with low embodied energy and embodied carbon. A particular focus was to demonstrate the technical possibility of achieving net Zero Energy as well as providing data and to stimulate debate concerning the need to move to an integrated and holistic sustainability paradigm in building design and

construction (Figure 3.13). The study introduced a particular composition of wall and roof components and made a comparative study with traditional cavity wall construction across a range of required U-Values and energy targets (Daly, 2008).

Figure 3.13 The iLEED demonstration house in Ireland.
Source: Doyle, 2011

The energy use design standards were based on the German Passivhaus Institute (PHI) standards. These include ultra-low space heating coupled with the use of integrated technologies for energy efficiency and use of renewable energy (Feist, 2007). The study also used the UK BRE Eco Homes environmental assessment method, which was later integrated into UK building regulations via the UK Code for Sustainable Homes (CLG, 2006). These standards measure the sustainability of a home rating the whole dwelling as a complete package.

The overall target for the project was to reduce the total annual demand of the house, including appliances and cooking, to 6500 – 7000 kWh/yr of delivered energy. This would be met through an all-electric solution provided by on site PVs (a 70 m² array) and a 2.5 – 3 kWe wind turbine (Figure 3.14). The all electric approach is considered optimal for a zero energy house and is compatible with using renewable energy (Daly, 2008).

Figure 3.14 The iLEED demonstration house showing integrated energy efficiency and renewable energy solutions. These include a mechanical ventilation system with heat recovery (MVHR), solar hot water, ground sourced heat pump, photovoltaic panels, and a wind turbine. (Adapted from: Daly, 2008).

The study argued that embodied energy for a low energy house could be up to 50% of operating energy over 60 years. As the project put emphasis on being passive, zero carbon and ultra-low energy in use, embodied energy becomes a significant proportion of the total life time energy and was given greater priority in the design. The design favoured materials of lower environmental impact and these tend to correlate with renewable, organic materials such as timber frame wall construction and lime rendered wood wool slab cladding boards with hemp quilt insulation. The environmental considerations included resource availability and reserve, pollution indices, and process resource consumption, such as water use.

In conclusion, the project demonstrated thresholds where the relative importance of embodied energy and embodied carbon increases as designers aim to achieve lower energy consumption. The project did not report on behavioural change.

3.5.2 The Utah House

Located at the Botanical Centre in Kaysville, the Utah House is a demonstration facility built and operated by Utah State University. It was opened to the public in 2003 to showcase sustainable building design and construction technologies. Its purpose was to demonstrate, educate, and empower people regarding sustainable ways of building homes, as well as promote energy efficiency practices, water conservation, healthy indoor environments, sustainable use of resources, and universal design principles (Figure 3.15).

The building is a three-bedroom dwelling with a kitchen area, a lounge that can be used as a classroom, three bathrooms, and several outdoor gathering areas. It is open to the public for tours, workshops, and other community functions. It aims to demonstrate five key areas: sustainable building materials and techniques, energy conservation, water conservation, healthy indoor air, and an accessible layout (Dietz et al., 2009).

Figure 3.15 The Utah House. Source: <http://www.usubotanicalcenter.org/plan-an-event>

More than 10,000 adults and children attended educational programmes at the house in 2007 (Dietz et al., 2009). A survey was sent to visitors to assess the level of knowledge about the key areas, and what people *did* in response to their visit. The aim was to determine if their visit to the house either influenced their level of knowledge or, more importantly, their behaviour. Significant increases were observed in self-reported knowledge in all five key areas indicating the

effectiveness of the facility as an educational tool. Several statistically significant relationships were observed between visitors' knowledge of issues, how important people think these issues are, and the number of actions they performed as a result of the visit, although no strong predictor of involvement in pro-environmental behaviour emerged (Dietz et al., 2009). This is consistent with Hungerford and Volk's (1990) finding (see Section 3.3.1) that despite correlations between pro-environmental behaviour and possessing environmental knowledge, linear progression from knowledge to awareness and then to action is not supported. McKenzie-Mohr (2000) endorsed this finding.

At Utah respondents developed more knowledge about energy efficiency and water conservation compared to the other three areas, but the differences were small. Variations according to gender and education were observed with the differences in importance to individuals of the five key areas being slight. For actions as a result of the visit, 63% of people reported implementing at least one action as a result of their visit to the Utah House. Participants in large group tours were found significantly less likely to engage in at least one of the target activities (Dietz et al., 2009, pp.1712, 1713).

3.6 Summary

According to Kollmuss and Agyeman (2002), pro-environmental behaviour simply means "behaviour that consciously seeks to minimise the negative impact of one's actions on the natural and built world". This entails initiating shifts in people's attitudes towards environmental knowledge and sustainable actions. For individuals, engagement in pro-environmental behaviour is considered a consequence of the complex interactions between internal factors (knowledge, desire to act, and emotional responses) and external factors (economic constraints, convenience of the activity, and social pressures), as well as the individual's perception that their action is likely to make a difference.

Subsequently, design for behaviour change as a field of study, focuses on exploring ways that designers are able to apply ideas to effect change in behaviour

towards the environment through design. This includes educational, technical, and product and spatial interventions. Nonetheless, intervention studies are not yet common within design research. In the field of product design, recent studies have speculated about products and services intended to influence sustainable behaviour, ease environmental concerns, and address other areas of social benefit (Lockton et al., 2013; Bhamra et al., 2011; Lilley et al., 2005). Through the design and construction of human environments, architects have been engaged with influencing human behaviour. The need now is to build on previous experiences and seek a new design culture that looks at ways of integrating design knowledge with pro-environmental practices.

Chapter 4: Measuring Sustainability

“Every building is a forecast. Every forecast is wrong.”

Stewart Brand (How Buildings Learn, 1994, p.100).

As a result of the increased effects buildings are having on the environment and awareness of the importance of sustainable building concepts and practices in minimising these, a number of organizations have developed standards, codes, methods, and rating systems that allow government agencies, building professionals, and the public to adopt sustainable building practices with confidence (Mpakati-Gama et al., 2012).

4.1 Sustainability rating systems

Most sustainable building standards and rating systems are sets of guidelines created by standards development organisations that establish minimum requirements for the elements of sustainable buildings (Potbhare et al., 2009). From the time of their introduction more than 20 years ago, these rating systems have received growing interest and significant research activity has centred on their development and promotion (Potbhare et al., 2009). Since 2005, the green building market has been growing at a rate of 15% per annum, and by 2014 the building stock certified to high sustainable standards is around 4% per annum worldwide (WGBC, 2014).

Some of the major rating systems and assessment tools currently in use include BREEAM (United Kingdom), Passivhaus (Germany), LEED (United States and Canada), Green Star (Australia and New Zealand), and CASBEE (Japan). Due to its complexity and lack of flexibility in the choice of points only a handful

number of projects have been CASBEE certified (Potbhare et al., 2009). The following is, therefore, an overview of the remaining, more commonly used rating systems.

4.1.1 BREEAM, the United Kingdom

Developed in the UK, the Building Research Establishment Environmental Assessment Methodology (BREEAM) is considered to be the world's first and most widely used method of assessing, rating and certifying the sustainability of buildings (BREEAM, 2013, p.559; Potbhare et al., 2009). Introduced as a voluntary scheme, it uses recognised measures of performance set against established benchmarks to evaluate a building's specifications, design, and construction. BREEAM criteria cover the management of building processes, energy, water, land use and ecology, health and well-being, transport, materials, waste, and pollution. A weighting system is applied in order to obtain the final BREEAM rating, which can be Excellent, Very good, Good, and Pass (BREEAM, 2013, p.347).

The first version of BREEAM was launched in 1990 and was designed as an environmental performance checklist for assessing new office buildings. This was followed by versions for other buildings types such as stores, industrial units, and existing offices (BREEAM, 2013, p.559). In 2000, EcoHomes, a version of BREEAM, was launched as an assessment method for rating and certifying the performance of new homes. Ecohomes later formed the basis of the Code of Sustainable Homes (CSH), a scheme developed for the UK Department of Communities and Local Government (CLG) in 2006 by the Building Research Establishment (BRE) and the Construction Industry Research and Information Association (CIRIA) "to enable a step change in sustainable building practice for new homes" (CLG, 2006, p.4). It was intended to be a single national standard for the design and construction of sustainable homes and an environmental assessment method for rating and certifying the designed performance of new homes (CLG, 2006, p.4). As the LC will be planned as a residence, it is appropriate to investigate the CSH scheme as a means of checking its

sustainability credentials. In 2014, and in response to the Housing Standards Review, the UK Government confirmed it would cancel the CSH and instead in 2015 incorporate rules on energy efficiency into the building regulations (Mark, 2014). This is after CSH was used in this project.

The CSH is a six-level rating system based on the home's performance against nine sustainability criteria, which combine to assess the overall environmental impact. Level 1 Star is entry level above the requirements of Building Regulations while Level 6 Star is the highest, suggesting excellent developments with regard to sustainability. The CSH is applied in two stages, the first being the design stage and the second the construction stage. The nine sustainability criteria for new homes are energy and CO₂ emissions, water, materials, surface water run-off, waste, pollution, health and well-being, management, and ecology (CLG, 2006, p.4, 5). Each category holds a different weighting factor depending on its relative importance (CLG, 2010, pp.12, 13). These weighting factors were derived from studies involving a wide range of stakeholders (CLG, 2008, pp.13, 14).

The Sustainable Development Commission (SDC) was keen on developing a version of the Code for Sustainable Buildings for the existing housing stock. In 2006, *Stock Take* was introduced to provide guidelines for refurbishing existing homes to a high standard of environmental efficiency, highlighting its benefits for occupants of improved comfort and reduced running costs. The guidelines cover energy and carbon emissions, water, material sourcing and recycling, construction and demolition waste, as well as household waste recycling and treatment (SDC, 2006, pp.7–11). The 2010 version of the CSH raised the levels set for the energy criteria. This meant raising the baseline Targeted Emission Rate resulting in houses designed to be thermally more efficient than those built to the previous version of CSH (CLG, 2010, p.32).

In 2010, BRE Global positioned BREEAM within an overall framework for the environmental, social and economic assessment of the built environment known as the Code for a Sustainable Built Environment. The new framework is designed

to allow organisations in other countries to adapt BREEAM to their local context and affiliate their processes, products and tools with BREEAM across all life-cycle stages of buildings and infrastructure. This satisfies BREEAM's objectives of being a worldwide instrument. At the highest level, this Code forms a vision statement for a sustainable built environment. The Code is interpreted through a Core Technical Standard and a Core Process Standard (Figure 4.1), both supported by Core Science (BREEAM, 2013). Licensed BREEAM assessors carry out assessments with a fee charged for the certification services (BREEAM, 2013).

Figure 4.1 The Code for Sustainable Built Environment is interpreted through a Core Technical Standard and a Core Process Standard, both supported by Core Science.

Source: <http://www.breeam.org/page.jsp?id=347>

The Code for Sustainable Homes as a version of BREEAM offers an overall performance assessment of a broad range of issues with an understanding of the relative importance of these. Since some issues were awarded more points than others, the system also includes embedded weightings of importance. The advantage of such a system is its simplicity, which allows it to be used for assessing projects in diverse locations (such as this research project). As the weightings of relative importance are developed for one location, these need to be adjusted for other locations. This is a normal process, and happened when category weighting adjustments were made to the Green Star rating system in Australia and New

Zealand, which in turn was derived from BREEAM and LEED (NZGBC, 2009, p.249).

In the *Energy and CO₂ emission* category of CSH it is assumed buildings will experience significant change in their lifetime, making it desirable to think about the life-cycle of the building fabric components, including techniques related to low or zero energy solutions, as well design for re-use and recycling at the end of the building life or that of its components. Consideration of local climate may require adjusting the Heat Loss Measurement Criteria in the Energy and CO₂ emission category when adapting CSH to this research project, as summertime overheating in Hawke's Bay can be an added stress on building thermal performance.

4.1.2 Passivhaus Institute, Germany

In 1996 in Germany, the Passivhaus Institute (PHI), an independent research organisation, was responsible for developing and promoting the Passivhaus (PH) building programme (Feist et al., 2007, p.7). As a response to climate change and shortage of resources, it was an attempt to use energy much more efficiently and to switch to renewable sources of energy when required (Feist et al., 2005, p.1186). Feist et al. (2001, p.8) describe PHs as “buildings that assure a comfortable indoor climate in summer and in winter without needing a conventional heat distribution system.” The PH programme has gained considerable public interest due to the dramatic improvements in energy efficiency in buildings that have adopted its standards, and public discussions on the accelerating effects of climate change (IPCC, 2007). From 2007, PHs form a growing proportion of new buildings in Germany, Austria, and other places in Central Europe and beyond (Feist et al, 2007, p.7; ESRU, 2009), however overall numbers compared to the building stock are very low (Pass-net, 2013).

In principle, PH is a voluntary standard that offers a cost efficient and sustainable way of minimising the energy demand of new buildings while simultaneously improving the comfort level experienced by the occupants. It creates the basis for meeting the energy demands of new buildings entirely from renewable sources.

The efficiency of the approach relies on optimising the necessary components of the building, namely the building envelope elements, windows, and ventilation system (Feist et al., 2001, P.7). Studies show that minimising heat loss is the first step and is essentially more efficient than strategies mainly relying on the use of passive or active solar energy (Feist et al., 2001, P.7; Müller & Berker, 2013). This concept was recognised in the 1970s' European drives to improve operating energy efficiency, as this was the biggest part of energy use in buildings. Buildings were aimed at being self-sufficient in space heating and hot water supply in normal climatic conditions (Marszel et al., 2011).

PH sustainable design standards are performance-based design targets for specific energy conservation methods and sustainable architectural techniques and specifications. The aim is to create a sufficiently low annual space heating demand so conventional heating systems can be eliminated. The small amount of heat still required can be delivered by heating the air supplied by the ventilation system, a system necessary because of the need to make the building airtight. In practice, most PHs have an active heating system but with radically reduced energy demand (Müller & Berker, 2013). The annual space heating energy demand must not exceed 15 kWh/m² (Feist et al., 2007, p.14) (Figure 4.2).

Figure 4.2 Comparison of specific energy consumption levels of dwellings.
Source: Feist et al., 2001, p.7.

According to Feist et al., PHs need 80% less space heat than new buildings designed to the 1995 German Thermal Insulation Ordinance, *Wärmeschutzverordnung* (2001, p.8; Pass-net, 2013). To be confirmed as a PH, a fee is charged for evaluation by a certified Passive House Designer/ Consultant (PHIUS, 2013, p.5).

The success of the PH concept was established through a strong scientific basis for the fundamental principles of the standard, a sound certification system, *demonstration* through good examples, the creation of a protected market niche, extensive training activities, and professional marketing of the concept, standards, components, and technologies (Müller & Berker, 2013). The PH requirements are considered a precondition for the nearly Zero Energy Building (nZEB) standard (see Section 4.3) that by the end of 2020 will be applied to all new buildings in all EU member states (EPBD, 2010, p.13).

From the social and cultural perspective, the success of PH in Central Europe can be attributed to forming a devoted community of like-minded advocates that share the same norms and values. For example, in the state of Vorarlberg in Austria, unique cultural and social conditions that predate the PH have created the ground for development of the concept and a standard for that area. Cultural norms and values vary geographically and have influenced established calculation standards and methods (Müller & Berker, 2013).

In 1998, the European project Cost Effective Passive House as European Standards (CEPHEUS) was established with 221 housing units complying with the PH standards, built in five European countries. All buildings were equipped with a balanced mechanical ventilation system with heat recovery (Figure 4.3). Half also had ground heat exchangers, and nearly all used air heating in combination with the ventilation system (Feist et al., 2005, pp.1189–1190; Feist et al, 2001, pp. 7–8). Upon completing and occupying the housing units in 2001, it was concluded that CEPHEUS was a complete success in terms of the functional viability of the PH concept at all sites, achievement of the space heat savings target with savings of more than 80% in the first year, practical

application of PHs in a broad variety of building styles and constructions, project-level economics, and satisfaction of the building occupants (Feist et al., 2001, p.1).

Figure 4.3 A registered CEPHEUS project in Hannover-Kronsberg, Germany. The cross section shows the mechanical ventilation system with heat recovery and ground heat exchanger.

Source:

https://en.wikipedia.org/wiki/Passive_house#/media/File:Passive_house_scheme_1.svg

The results confirm that indoor temperatures can be maintained in PHs with a ventilation and air heating system. To achieve these performance standards in Germany the exterior building elements must have a U-value below $0.15\text{W}/(\text{m}^2\text{K})$, the external envelope must be constructed with minimum thermal bridges, the building envelope must be airtight, all glazing must have a U-value below $0.8\text{W}/(\text{m}^2\text{K})$, the ventilation system must have the highest energy recovery efficiency available, hot water systems must be designed to minimise heat losses, and electrical appliances must be highly efficient (Feist et al., 2007, p.14). It is significant that what makes a building a PH is the integration of the appropriate components rather than the combination of individual parts (Feist et al., 2007, p.14). PHs in the CEPHEUS project were designed as terraced units with two party walls to minimise the building envelope to total floor area ratio. In comparison, the Log Cabin project at Otatara is detached so has a much bigger

building envelope to floor area ratio and this will impact on the amount of insulation needed if it is designed to PH standards.

Regarding whether German PH solutions be used in another climatic zone, Badescu and Rotar (2012) focused on whether German design solutions would ensure the fulfillment of PH standards in Romania. Their analysis showed that by hypothetically moving a given building from Germany to Romania, the two parameters of ambient temperature and global solar irradiation have a contrary effect on the level of heating demand. Further analysis showed that heating demand and primary energy need, two requirements of the PH standard, were fulfilled for all German and Romanian locations involved in the study. Furthermore, the heating demand in Romania, unlike in Germany, decreases linearly with decreasing latitude. In a large portion of Romania, mainly under latitude 45° N, some German PH design solutions, such as the level of thermal insulation, can be relaxed while the PH energy related target is still reached. Less insulation could bring cost savings (Badescu & Rotar, 2012). Overall, the savings in running a PH can be balanced by any extra costs in meeting the higher insulation requirements.

4.1.3 LEED, United States and Canada

In North America, Leadership in Energy and Environmental Design (LEED) is a credit based green building programme aimed at promoting more sustainable buildings. It covers new and existing commercial, institutional, and residential buildings. Developed and administered by the US and Canadian Green Building Councils (USGBC and CaGBC), the LEED programme is “...voluntary, consensus-based, and market-driven” (USGBC, 2009, p.xi). LEED includes a set of rating systems for the design, construction, and operation of green buildings, which are defined as being environmentally responsible and using resources efficiently (USGBC, 2009, p.xi; Newsham et al., 2009).

The LEED green building rating system encourages an integrated design approach that assigns credits (as points) for building design features that are

considered to improve sustainability. It includes reductions in energy use and improvements in indoor environment quality (USGBC, 2014a). The credits are awarded to buildings in the five environmental categories of sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. There is an additional credit earning category of innovation in design (USGBC, 2009, pp.vii, xii). Regional bonus points may also be given for recognising local conditions in environmental design and construction practices. Based on the number of credits a project achieves, it is assigned a rating with the highest being Platinum followed by Gold, Silver, and Certified (USGBC, 2009, pp.vii, xii). The USGBC is committed to rating one million commercial buildings and ten million homes by 2020 (Potbhare et al., 2009). A registration fee is required to start the process of applying for LEED accreditation and a certification fee is needed if the project gains one of the four certification levels (USGBC, 2014b).

Newsham et al. (2009) carried out a re-analysis of measured energy use data from 100 LEED certified buildings and found that, on average, LEED buildings use 18–39% less energy per unit of floor area than conventional buildings, but despite these average savings, 28–35% of LEED buildings used more energy than conventional buildings. The Energy and Atmosphere category in LEED 2009 includes heating, ventilation, air conditioning, and refrigeration, as well as lighting and daylight controls, domestic and hot water systems, and renewable energy systems (USGBC, 2009, p.31). According to LEED, energy efficiency comes from improving the mechanical, electrical, and hot water systems in buildings. Thus, there is little incentive to improve the building design from passive solar aspects. Moreover, for a building to be rated under LEED, it has to have mechanical heating and cooling systems (Shaviv, 2008). Further, there is no statistically significant relationship between LEED certification level and energy use, as LEED Gold/Platinum buildings did not have a better energy performance than LEED Silver buildings (Newsham et al., 2009).

Because in LEED 2009 passive solar energy is not mentioned as On Site Renewable Energy under the Energy and Atmosphere category (Shaviv, 2008), a project like the Log Cabin at Otatara that relies on minimising energy use would not be graded highly by LEED and consequently may not even achieve green building accreditation.

With the additional category for innovation, in the LEED system a building can achieve a higher rating through using new and better materials and HVAC systems. This seems to favour the business and trade side of the building industry, while a building with innovative climatic design and passive energy solutions that require no mechanical heating or cooling cannot be assessed by LEED. The system's approach is seemingly more consensus-based and publicly reviewed compared to BREEAM, however the USGBC has been criticized for being influenced by manufacturers, contractors, and developers (Sleeuw, 2011, pp.9, 10).

Finally, the LEED certification process is relatively expensive compared to BREEAM, because its business model is based on a monopoly of supply of assessment (Sleeuw, 2011, p.10).

4.1.4 Green Star, New Zealand and Australia

In 2009, the New Zealand Green Building Council (NZGBC) introduced Green Star as a comprehensive, national, and voluntary environmental rating scheme and tool with which to measure the environmental attributes and performance of buildings (NZGBC, 2009, p.3). It was a modification of the Australian Green Star rating system given the differing markets, building legislation, and physical environment. The Green Star framework is also aligned with major international rating tools, including BREEAM and LEED (NZGBC, 2009, p.3). The environmental impact of a building is assessed in relation to its site selection, design, construction, and maintenance. There are eight separate categories plus an additional one for innovation (Table 4.1). All categories contain credits where points are awarded for actions that prove a level of performance. A weighting

factor is applied to each category reflecting the relative importance of the issue addressed. The most weighted are Energy (25%) and Indoor Environment Quality (20%). The overall score out of 100 is then translated to a Green Star rating from 1 to 6, where the latter is the highest (NZGBC, 2009, pp.4–5).

Issue	Rating system		
	LEED (%)	BREEAM (%)	Green Star (%)
Management	7*	15	10
Indoor Environment Quality	22	15	20
Energy	24	12.5	25
Transport	6*	12.5	10
Water	7	5	10
Materials	16	10	10
Ecology	13	15	10
Emissions	4*	15	5
	100	100	100

* Under Sustainable Sites category in LEED.

Table 4.1 Credit Category percentages in Green Star, LEED and BREEAM.
Source: NZGBC, 2009, p.249.

The weighting values were derived from the OECD report on Environmentally Sustainable Buildings: Challenges and Policies (2003), as well as comparisons with BREEAM, LEED, and Australia's Green Star–Office Design (NZGBC, 2009, p.249). Table 4.1 does not display the latest version of BREEAM since its purpose is to compare credits between the three systems when Green Star NZ was introduced. It reveals Green Star weightings are very much in line with LEED in most categories, but there are noticeable differences in the distribution of weightings with BREEAM in Energy, Emission and Indoor Environment Quality categories. The Energy percentage in BREEAM is significantly lower than that in both LEED and Green Star, because the latter include issues covered by Pollution and Management in BREEAM. On the other hand, BREEAM's Transport percentage is higher as the travel plan credit is more rigorous over accessibility of public transport and encouraging alternatives to the car as a high environmental impact form of transport (Sleeuw, 2011, p.9). BREEAM also

allocates a much higher point percentage for Emissions in comparison to the other two systems. This is due to its greater emphasis on issues that have an environmental impact as determined by its stakeholders and team of experts, and because it has a broader scope when it comes to social impacts (Sleeuw, 2011, pp.6, 7).

In order to improve the performance of the housing stock in New Zealand, the Building Research Association of New Zealand (BRANZ), the New Zealand Green Building Council (NZGBC), and Beacon Pathway, collaborated to produce and operate a residential rating tool called Homestar. This is able to evaluate the environmental attributes of New Zealand's new and existing homes in terms of energy, health and comfort, water, and waste (BRANZ, 2013a; NZGBC, 2013). The rating tool was compared to international standards such as LEED for Homes in the USA and Canada and the Code for Sustainable Homes in the UK (NZGBC, 2013). The Homestar rating tool is similar to the Green Star NZ system where a dwelling is assessed against a set of pre-determined benchmarks. It is a 0–10 star rating system that allows users to self-rate existing dwellings in the range of 0–4 stars while providing an independently certified rating above 4 stars. Hence, the system will assist in identifying and prioritising the improvements needed to upgrade the performance of dwellings (BRANZ, 2013a).

The Homestar manual maintains a significant focus on the commercial benefits to property owners when upgrading their home to achieve higher performance levels. It highlights the findings of international studies where 'environmentally certified homes' are sold for larger sums with reduced time on the market (NZGBC, 2009, pp.7–10).

4.1.5 Discussion of rating systems

To compare relevant rating systems and identify probable criteria for the refurbishment brief of the Log Cabin, and accepting the Green Star rating system is already aligned to BREEAM and LEED (NZGBC, 2009, p.3), a comparison

chart of their criteria was developed (Table 4.2). This reveals LEED has no direct measurement of management and well-being, BREEAM omits indoor air quality, and Green Star omits well-being. Furthermore, LEED has no independent category for transport, but 4 out of 15 sub-criteria in the sustainable sites category are dedicated to this. Two categories of LEED, water efficiency and materials and resources, cover waste in each single sub-criterion. As well, three out of the 15 sustainable sites sub-criteria in LEED concern measurements of pollution.

Categories	Rating System		
	BREEAM	LEED	Green Star
Management	Management	Sustainable Sites	Management
Energy	Energy	Energy and Atmosphere	Energy
Transport	Transport	Sustainable sites	Transport
Resources	Materials	Materials and Resources	Materials
Innovation	Innovation	Innovation in Design	Innovation
Indoor	NA	Indoor Environment Quality	Indoor Environment Quality
Pollution	Pollution	Sustainable Sites	Emissions
Well-being	Health and Well-being	NA	NA
Water	Water	Water Efficiency	Water
Waste	Waste	Water Efficiency + Materials & Resources	Management
Land	Land Use and Ecology	Regional Priority	Land Use and Ecology

Table 4.2 The three rating systems and their criteria.

Although the three rating systems have a considerable degree of agreement in terms of their aims, approach, and structure, there are significant differences in environmental issues addressed, benchmarks, and methods.

Based on Table 4.2, some characteristics of the LEED, BREEAM, and Green Star rating systems and PH may affect their validity as rating systems. In all these sustainability rating systems the balance between flexibility in choice and performance is workable, the environmental and practical implementations are addressed, and the information related to the credits is simple to understand. However, no rating system covers every category. Thus, there will have to be further investigations into the criteria for the Log Cabin project, to ensure its sustainability credentials.

Apart from PH, the rating systems discussed above measure the environmental impact as a points accumulating exercise of adding the scores in the various categories, and do not measure holistic sustainability. The latter is important for a demonstration project intended to teach about living and building sustainability. Furthermore, according to Potbhare et al. (2009), prior to establishing a project's criteria, the characteristics that might affect its recognition must be identified and measured.

Finally, and from a holistic point of view, BREEAM, LEED, and Green Star are useful in assessing buildings against a set of criteria and ranking their environmental performance for commercial purposes. However, against the background of climate change and discussions around minimising the use of fossil fuel energy, people need to realise the need for a dramatic improvement in the energy efficiency in buildings. This is where the PH specifications can offer economically viable, performance reliable, and highly comfortable houses, although going beyond PH energy savings is also possible, as discussed in section 4.2.

4.2 Zero Energy Buildings

Buildings consume over 40% of total primary energy worldwide and at 24% are significant contributors to greenhouse gas emissions, particularly CO₂ (IEA SCH Task 40, 2012, P.1; Baden et al., 2006; USDE, 2007; Crawley et al., 2009). Thus,

reducing energy consumption and using energy from renewable resources in buildings are important measures to reduce fossil fuel energy dependency and greenhouse gas emissions (EPBD, 2010, p.13; IEA SCH Task 40, 2012; USDE, 2011). Consequently, in the last few years, the concept of a zero energy building (ZEB) has gained wider attention and is perceived as a future, realisable target for building design (Marszal et al., 2011; Sartori et al.).

In order to regulate the communication, use, and information exchange between various countries involved in thinking about ZEBs, Marszal et al. singled out the need for a clear and unanimous definition of what ZEB really means, and a well-outlined method for calculating the energy balance (Marszal et al., 2011), a move supported by other researchers (Sartori et al., 2010; Mlecnik et al., 2011).

4.2.1 What is a ZEB?

The essential concept of a ZEB is one with reduced energy requirements for building materials, services, and operation, with the objective of meeting all energy requirements “from low-cost, locally available, non-polluting, and renewable sources. At the strictest level, a ZEB generates enough renewable energy on site to equal or exceed its annual² energy use” (Torcellini et al., 2006).

According to Torcellini et al. (2006), connections to the electricity grid or use of traditional energy sources such as natural gas are allowed in situations when on-site energy generation does not meet all needs. In the former, surplus energy (electricity) production can offset later energy use, especially from one season to the next (summer to winter). In this case, these are called net-zero energy buildings (Net ZEB). If gas is used the energy consumed will have to be off-set by an equivalent amount of on-site electricity, to achieve a net zero energy balance. Achieving a ZEB without the grid is very difficult, as the current generation of storage technologies is limited (Torcellini et al., 2006). This makes Net ZEB the

² Most calculation methods of ZEB are based on the annual balance as most building energy simulation programmes give the annual energy use of a building (Torcellini et al., 2006, pp.10, 11; Laustsen, 2008, pp.71, 72; Marszal, 2011).

preferred approach in this research since the project is to be a demonstration building for the community.

Strategies for improving building performance through implementing ZEBs have been discussed in countries belonging to the International Energy Agency (IEA), including New Zealand. In 2010, the IEA established Task 40, to study low energy buildings and develop a common understanding of a ZEB, highlighting the IEA's international vision of adopting Net ZEB as a long-term energy policy goal. To achieve this, the IEA recommended documenting Net ZEB 'demonstration' projects of architectural quality (IEA SCH Task 40, 2012).

The US congress authorised a ZEB policy as part of the 2007 Energy Independence and Security Act (USC, 2007). According to this Act, it is mandatory to develop and establish net zero energy in newly constructed commercial building in the US by 2030, in 50% of the commercial building stock by 2040, and in all commercial buildings by 2050 (USC, 2007, p.113). In Europe a similar policy was endorsed with the 2010 updating of the Energy Performance of Buildings Directive (EPBD) (IEA Task 40, 2012, p.1; Crawley et al., 2009; Marszal et al., 2011). In this policy measures will be taken to honour EU commitments to increasing the use of energy from renewable sources together with reducing energy consumption. By 2020 the EU is committed to reducing overall greenhouse gas emissions by at least 20% below 1990 levels (EPBD, 2010, p.13). In March 2007, the European Council (EC) also emphasised the need to increase energy efficiency in the EU by reducing energy consumption, endorsing a mandatory target of 20% by 2020. In February 2009, the EC called for that target to be made binding (EPBD, 2010, p.13, 14).

Globally, some buildings need heating and some cooling. For the latter, many examples of contemporary buildings have demonstrated ways of eliminating the need for cooling energy by employing passive design techniques, such as Glenn Murcutt's Marika-Alderton House in Australia (Fromont, 2005, p.218–227), and Karyono's Anggrek House in Jakarta (Karyono, 2010), as well as examples from

traditional buildings, such as the courtyard houses of the Middle East and India (Roaf et al., 2001, p.21). This would seem to be a more cost-effective approach and it seems odd this is not included in the IEA discussion of ZEBs.

4.2.2 A review of ZEB definitions

The term net zero energy first appeared in the US Congress Bill, Energy Security and Independence Act of 2007 (USC, HR6, Sec 422). It was intended for commercial buildings. A zero-net-energy commercial building was defined as a high-performance one designed, constructed, and operated on the basis of a greatly reduced energy requirement, sufficient to meet the balance of energy needs from non-greenhouse gas producing sources, thus having no net greenhouse gas emissions, and that was commercially viable (USC, 2007, Sec 422, p.113; Pless & Torcellini, 2010). In monetary terms, it is cheaper to reduce energy needs than to generate all or most energy for a building from renewable sources. Figure 4.4 sets out the progression to net Zero Energy Homes (ZEH) in the US.

Figure 4.4 The way to Net Zero Energy Houses (ZEH) in the US. Source: Laustsen, 2008, p. 72.

However, according to Marszal et al., a ZEB is a multifaceted concept with a number of approaches that focus on different aspects of zero energy such as on-site and off-site renewable energy generation systems, methods of interacting with the utility grid and distribution systems, greenhouse gas emission factors, and energy cost factors (Marszal et al., 2011, p.972). In New Zealand, because electricity is largely from hydro this means fewer emissions from using electricity

to heat and cool buildings. On the other hand, the manner in which the zero energy goal is defined affects the choices people make to achieve this goal and whether they can claim success, including the method by which the system's performance is calculated or monitored (Torcellini et al., 2006, p.2).

In a study for the US Department of Energy, Torcellini et al. (2006, pp.6–10) identified four different aspects in the bid to achieve net zero use of energy. These were the project goals, intentions of the investor, concern about the climate and the greenhouse emissions, and finally energy cost. Hence, the study proposed four different Net ZEB definitions. A Site Net ZEB produces on-site as much energy as it consumes over a year. A Source Net ZEB produces as much energy as it consumes over a year when primary energy is taken into account. An Emission Net ZEB produces as much emission free renewable energy as it uses from emission producing energy sources. Lastly, a Costs Net ZEB, generates at least as much income from exporting energy to the grid as the amount paid for energy services used over a year (Crawley et al., 2009). From the above options, it appears that Site Net ZEB is the most relevant for this research.

In the European Union, the definition of ZEB was discussed within the Energy Performance of Buildings Directive (EPBD) and then reorganised and adopted in 2010 (EPBD, 2010, pp. 18, 19). This involved approval of the definition of a nearly zero energy building (nZEB), this being a building with very high-energy performance where the near zero energy required must come from renewable resources, including those on-site or nearby (EPBD, 2010, p.6, 18). The Directive instructs EU members that by the end of 2020, all new buildings in the EU are to be nearly zero energy and after 2018, new buildings occupied and owned by public authorities must reach this standard (EPBD, 2010, p.21; Mlecnik et al. 2012). In 2012, most EU countries introduced nZEB, or highly energy efficient housing, including demonstration projects (Mlecnik et al., 2012; Mlecnik, 2012). However, in the fields of promoting and marketing buildings and materials, there is no clear and agreed definition for nZEB among researchers and market developers (Mlecnik, 2012). Currently, terms such as 'net zero energy' and 'net

zero carbon' in addition to 'low energy' and 'passive house' are proposed, although these can have different meanings in different regions. This may impact negatively on the compatibility of regional market development, appraisal systems, and create confusion (Mlecnik, 2012).

In the UK, a zero carbon building is one that is expected to operate with minimum energy needs and with any remaining energy supplied from renewable sources (Mlecnik, 2012). The terms 'zero carbon' and 'zero energy' have been considered as interchangeable (EPBD, 2011, p.7). However, 'zero carbon' buildings differ from 'zero energy ones' as the former can use electricity produced by CO₂ free sources, such as wind generators, nuclear power and PV solar systems which are not integrated into the building or do not exist at the construction site (Laustsen, 2008, p.71). According to the 2010 CLG guide, a zero carbon home is achieved when net CO₂ emissions resulting from *all* energy used in the dwelling are zero or better. This includes energy for space heating and cooling, hot water, fixed lighting, cooking, and plug-in appliances (CLG, 2010, 32–46).

Between 2008 and 2013 New Zealand researchers worked with those from 19 different countries on the Towards Net Zero Energy Solar Buildings programme under the umbrella of the International Energy Agency (IEA) Task 40. The objectives were to develop a common understanding, produce a harmonised international applicable definition framework, produce endorsed design process tools, develop advanced building design and technology solutions, and institute industry guidelines for Net ZEBs (IEA, 2014). The scope included new and existing buildings located within the climate zones of the participating countries. The overall conceptual understanding of a Net ZEB was an “energy efficient, grid connected building enabled to generate energy from renewable sources to compensate its own energy demand” (IEA, 2014). Roman Jaques (2014) from BRANZ, pointed to the fact there is no agreed common definition of a ZEB, but stated “conceptually, it is a building that can generate enough electricity from renewable sources to balance its energy demand over an average year”. He went

on to suggest a Net ZEB is one connected to energy infrastructure, so that “the energy taken from and supplied to the grid is balanced. The building uses the grid as a battery.”

4.2.3 A framework for achieving ZEB

The first attempts at ZEBs took place in the 1970s and 80s (Marszel et al., 2011). The focus then was essentially on zero space conditioning as in Europe this was the biggest part of building energy use. In recent years, it has been suggested that zero-energy should not focus solely on the energy used in the building operation phase, but also include the energy embodied in the building construction, so a life-cycle methodology calculation (LC-ZEB) was developed (Hernandez & Kenny, 2010). Hernandez and Kenny (2010) define an LC-ZEB as a building “whose primary energy use in operation plus the energy embedded in materials and systems over the life of the building is equal or less than the energy produced by renewable energy systems within the building.” In this scenario, allowing for the energy embedded in materials and systems makes Net ZEB more demanding and the energy balance harder to achieve. Hernandez and Kenny (2010, p.820) acknowledge limitations in this method in terms of the selection of primary energy as an indicator, the energy use calculation method, and the boundaries of embodied energy calculations. On the other hand, (Marszal et al., 2011) insist that embodied energy is not commonly considered in the calculations of energy use in a building and should, therefore, not form part of a ZEB.

According to Marszel et al. (2011), ZEB is a complex concept with a number of calculation methods, each one highlighting a certain aspect. They made a survey of twelve calculation methods for zero-energy, most of which considered the balance between energy generated by the building and that consumed by its users. Most calculation methods assume grid connected ZEBs, which for Marszal et al. (2011) raised two issues. The first was the balance between energy use and renewable energy generation, which was a design issues due to estimating use and sizing systems, while the second was about the energy delivered to the building and the energy fed to the grid, which would be measured. Their research concluded that the results of both balances were the same in most cases.

Mlecnik (2012, p.423) commented on the importance of adopting a standardised method of calculation for ZEB, including deciding on a unified unit for calculations. Since new terms and definitions are easily introduced, the challenge lies in providing and developing associated evaluation procedures and improving compatibility with local legislation. His analysis showed the practicality of 'Passivhaus' standards in the realisation of Net ZEB and zero carbon definitions and the usefulness of this for national energy policies (Mlecnik, 2012).

In the 2009 NZGBC Green Star rating system (see Section 4.1.4) only one category, energy, is directly linked to ZEB although it only goes as far as talking about minimising energy consumption and reducing greenhouse gas emissions (NZGBC, 2013a). In office buildings, the energy category is allocated a maximum of 32 points out of the available 138, which indicates that if a building achieves a high Green Star rating, it will probably not be a ZEB. In a similar way a building with a high Homestar score (see Section 4.1.4) may not necessarily be a ZEB.

4.2.4 Examples of ZEBs

In addition to the example of the Hockerton Housing Project in Southwell (see Section 3.4.4), Wang et al. (2009) have discussed possible theoretical solutions for a zero energy house design in Cardiff. They used EnergyPlus simulation software to analyse building materials, window sizes, and orientation options and TRNSYS 16 software to investigate the feasibility of zero energy houses using renewable electricity sources (wind and solar) and solar hot water systems. They found the annual electricity generated with PVs and wind turbines could meet the electricity required for lighting, appliances, and heating systems, with enough surplus energy to operate pump circulation in the system and electrical chargers for vehicles (Figure 4.5).

Figure 4.5 Scheme of grid-connected renewable electricity system. Source: Wang et al., 2009.

Their research predicted financial gain from the sale of electricity back to the grid. Their three suggested design steps were first to analyse local climate data and make the best use of local climate conditions, second to use passive design methods to minimise requirements for heating and cooling, and finally to investigate energy efficient mechanical and renewable energy systems for system design optimisation. Their study concluded that it is theoretically possible to achieve zero energy homes in UK weather conditions.

A second built example is the Eco Terra housing prototype in Canada. The objective was to develop a clear approach to home building that combined resource and energy efficient technologies. The project uses a modular construction system and was promoted in 2007 as Canada's first net zero-energy house. It is a two-storey detached building and space heating was expected to represent a significant part of the annual energy consumption. Energy requirements were estimated using locally developed HOT2000 software. With a contribution from passive solar techniques and renewable energy systems, the annual space energy requirements were greatly reduced.

A two-stage geothermal heat pump contributed to the interior space heating and cooling as well as assisting in water heating. Net metering arrangements with the local power company enabled the project to receive credits for the excess electricity generated by the renewable energy sources (Figure 4.6). The balance demonstrated near zero energy consumption for the project (Noguchi et al., 2008).

In the UK, SEArch® Architects created an initiative called Greening-The-Box aimed at adapting existing buildings to standards fit for a low carbon society. Implementing low invasive and low technology design techniques, a number of existing buildings were refitted to reduce carbon emissions, building running costs, and eliminate reliance on fossil fuels (RDT Solutions, 2014).

Figure 4.6 Annual energy consumption and production profiles of EcoTerra house in Canada.
Source: Noguchi et al., 2008

In 2011 Greening-The-Box strategies were applied to a 200-year-old residential property in High Wycombe and the results exceeded the performance of the average speculative builder's house as verified by the Standard Assessment Procedure (SAP). The low-tech solutions included passive solar design and high thermal mass building fabric. The design incorporated natural heating and ventilation without mechanical systems and achieved near zero carbon emissions. The architects called for developers in the UK to adopt the approach (Harrall, 2012).

4.2.5 Discussion of ZEBs

While the ZEB calculation method has a defined framework, it is primarily designed to address new buildings; Greening-the-box has addressed dealing with

the existing housing stock and upgrading this to ZEB level. Other examples of retrofitting existing buildings to be ZEB include Causone et al. (2015) and Ladhani and Parrish (2013). Given that this research concerns the retrofitting of an existing building, and considering the project's aim and focus is to be a demonstration tool for sustainable practices, it seems appropriate to attempt to achieve Net ZEB (see Sections 6.2.3 and 6.3.3). This means the building will be connected to the grid but at the same time will produce annually, from renewable resources, as much energy as it takes from the grid.

4.3 Passive solar design

According to BRANZ (2013a, p.2) the focus of passive solar design is to “keep occupants at a comfortable temperature using the home’s physical structure and site conditions alone, requiring little or no purchased energy for heating, cooling and ventilation.” With a strong dependency on climate and location, the passive design method is considered the most effective and economic strategy for energy conservation in buildings (Gong et al., 2012). In their analysis of 25 cities in 7 passive design zones across China, Gong et al. (2012) explored how energy consumption could be minimised in residential buildings through optimising the 7 passive energy saving measures of wall thickness, roof insulation thickness, external wall insulation thickness, window orientation, window-wall ratio, glazing type, and sunroom and overhang depth. The study found external wall insulation thickness and sunroom depth were the two most important parameters in the annual thermal load with contributions of about 70% and 10% respectively in 6 of the passive zones, while in the other zone, a region of hot summer and warm winter, roof insulation thickness and external wall insulation thickness together with window-wall ratio had a significant impact on thermal performance.

In a 2013 study of passive solar design in New Zealand BRANZ (2013b, p.1) provided an overview of high performance passive design for new homes. The study emphasized New Zealand’s favourable and mild climate, with a good number of sunshine hours, as an advantage in achieving its aim of “keeping homes at comfortable temperatures of between 18°C and 25°C, with minimal or

no cost year round”. The study used the design of the physical structure of the building and the site conditions to keep occupants at a comfortable temperature with little or no purchased energy for heating, cooling, and ventilation. In comparison to the PH recommendations of U-values below $0.15 \text{ W}/(\text{m}^2\text{K})$, the BRANZ study recommended a roof U-value between 0.217 and $0.182 \text{ W}/(\text{m}^2\text{K})$, walls of between 0.278 and $0.333 \text{ W}/(\text{m}^2\text{K})$, floor of $0.333 \text{ W}/(\text{m}^2\text{K})$, and windows between 2.50 and $1.88 \text{ W}/(\text{m}^2\text{K})$ (BRANZ, 2013b, p.4). In another study, BRANZ (2013a) specified the minimum insulation targets in New Zealand, measured in construction R-values (the lower R-values are for the warmer regions), to achieve zero, or near zero, space heating requirements in conjunction with other passive solar aspects. These were R 4.6 – R 5.5 for the roof, R 3.6 for walls of low mass construction and R 3.0 for walls of high mass construction, a fully insulated concrete floor slab with continuous horizontal insulation underpad and perimeter insulation, R 3.0 for timber floors, and R 0.4 – R 0.53 for windows. These are lower values than the PH specifications for a similar outcome provided that other factors to do with building placement, building layout, glazing, shading, thermal mass, and ventilation are considered. For the Log Cabin, what can be achieved given the solid timber walls will have to be assessed against both BRANZ recommendations and the PH specifications.

Thermal mass, such as a concrete floor or brick wall, placed inside an insulated space, can moderate the daily temperature swings, reducing the overall heating demand and lowering over-heating in warm weather (BRANZ, 2013a, p.7). The ancient idea of using thick walls to trap the sun’s heat during the day and releasing it slowly and evenly at night to heat the building spaces was known to the Romans, but was revisited by the French engineer Trombe in the late 1950s (Kachadorian, 1997, p.15). Today Trombe walls (Figure 4.7) are an effective feature of passive house design in cold climates with clear sunny days, such as certain mountainous regions in Europe (Torcellini & Pless, 2004).

Figure 4.7 Schematic drawing of a Trombe Wall.

Source: http://www.new4old.eu/guidelines/d6_part2_h5.html

An optimally situated sunroom (or a solar greenhouse/conservatory) could also be a passive solar design component (Figure 4.8). Direct solar gain retained in the thermal mass heats up the air, which can be brought into the interior living space by a combination of a shared mass wall to the rear of the sunroom and vents that permit convection air exchange between the sunroom and living space (EECA, 1994, p.203; Kachadorian, 1997, pp. 138–143).

Figure 4.8 Design for the sun: sunroom, Germany. Source:

[https://commons.wikimedia.org/wiki/File:Wintergarten_\(Eingefahrener_Sonnenschutz\)_ \(Anemometer\).jpg](https://commons.wikimedia.org/wiki/File:Wintergarten_(Eingefahrener_Sonnenschutz)_ (Anemometer).jpg)

Gong et al.'s (2012) study in China found transferring the heat from a sunroom and the ability to store and re-radiate it into the interior space in sunless hours increases the passive solar effect for cold and mild areas and helps keep the indoor temperature stable.

Given the high winter sunshine hours and no requirement for summer cooling, passive solar design would seem an obvious strategy for New Zealand homes. However, the earthquake code requirements mean that most houses are lightweight timber framed, and often built above ground. Despite this issue, concrete slab on ground, which could provide thermal mass, has grown from 3% of new build post WWII to 40% by the 1980s and nearly 80% by the end of the 20th century (Page, 2014).

As passive solar design focuses on minimising building energy consumption while keeping occupants at a comfortable temperature (Section 6.3.1), the aim here is to use passive solar principles in the LC conversion (Section 6.3.2) whilst recognising that being an existing solid timber building is not an ideal starting point for storing solar energy. Apart from thermal mass, there is also less control over aspects such as building orientation, window-wall ratio, and weather tightness.

4.4 Criteria for the Log Cabin conversion

At the time of writing this research, none of the standards discussed in this chapter deals with rating the building in use, which is important if the Log Cabin is to become an educational tool. As a result, when it came to the design stage (see Sections 6.2.4 and 6.4.2) students were guided towards the comprehensive CSH and the PH standards as being most relevant for creating a building that was also a teaching tool. The emphasis of New Zealand Homestar was felt to be too much on the marketing advantages of retrofitting houses to be more sustainable, and all aspects covered by Homestar could be found within CSH and PH standards.

4.5 Summary

Rating systems help determine the level of environmental performance in both construction and operation by awarding credits for the use of building features that support sustainable design in categories such as energy, water conservation,

waste management, building materials, and health. The number of credits generally determines the level of achievement (British Colombia Forest Facts, 2011). This chapter has discussed the major rating and assessment tools for buildings, concluding that CSH, a version of BREEAM, together with the German PH standard could be of use in developing targets for the Log Cabin conversion.

At present there is no international agreement on defining a ZEB, however Net ZEB remains a target for the Log Cabin project, which will adopt the strategy of trying to be carbon neutral in an average year, by producing as much energy as is taken from the grid.

Considering the design criteria for energy in this research project, a strategy of minimising energy demand while improving the comfort level experienced by the occupants and achieving a zero carbon balance seems appropriate. The low-tech solutions behind passive solar design create a basis whereby it is possible to meet the remaining energy demands entirely from renewable sources. This approach is appropriate in sending an appropriate message about minimizing energy requirements.

Chapter 5: Methodology and Approach

“In one sense, architectural research has been conducted throughout the history of architecture.”

Linda Groat and David Wang (Architectural Research Methods, 2002).

This chapter sets out the overall research approach, design, and methods used in this thesis. The thesis is explorative, predominantly making use of qualitative methods, being structured around looking at environmental values and influencing sustainable behaviour through a building.

5.1 The gap in knowledge

Section 2.1 suggested there is convincing evidence that exponential growth in both world population and the material economy are together exerting stresses on the finite resources of the planet to the degree current human impact is unsustainable (Meadow et al., 2004; Meadow et al., 1972; CIB, 1999; UN-HABITAT, 2006). The resultant climate change (UNDP, 2007) is partly the result of building activities, which account for 24% of greenhouse gas emissions, particularly CO₂ (IEA SCH Task 40, 2012; Baden et al., 2006; USDE, 2007; Crawley et al., 2009) (see Sections 4.2 and 2.3.4).

Chapman (2009) believes sustainability issues are mostly related to behaviour rather than technology or production. Buchanan (1989, p.93) believes designers are historically involved in influencing the shaping of society, and setting patterns for human actions, while Redström (2006) pointed out that design is inherently persuasive. Meanwhile, Dietz et al. (2009) found CO₂ emissions from US houses could be reduced through behaviour change with little or no reduction in household well-being. This suggests the need for design that encourages

behaviour change towards being environmentally responsible (Redström, 2006; Lockton et al., 2013; Lilley et al., 2006; Bhamra et al., 2008).

The New Zealand government recently introduced guidelines to help the public make their houses more *sustainable* (EECA, 2009; EECA, 2014). Given that that 45% of houses in New Zealand were constructed over 50 years ago (Leah, 2015, p.25; Page & Ryan, 2010) refurbishing the existing building stock in New Zealand is vital (see Section 2.3.5). Consequently, education about technologies and techniques that reduce fossil fuel energy dependency and greenhouse gas emissions are vital (EPBD, 2011; IEA SCH Task 40, 2012; USDE, 2011).

From this emerges a gap in knowledge in how a building that uses techniques for sustainability might influence sustainable behaviour in those who come into contact with it. This is the focus of this thesis and the three research questions (see Section 1.3):

1. *Why do people choose to engage with the various stages of a demonstration project for sustainable building,*
2. *How does this engagement relate to the individual's environmental behaviour and values, and*
3. *Will this engagement lead to further adoption of sustainable practices?*

5.2 Research approach

A research approach should aim to arrive at an understanding of a certain problem or phenomenon, in this case a demonstration building that functions as a means to convey examples of sustainable practices. This is an *explorative* approach (Shields & Rangarajan, 2013, pp.109, 110). The method used is *qualitative* and the research process can be described as *inductive*, being an approach with a starting point in the empirical material from which theory is developed by way of discovery (Fleck, 2009, pp.12, 69). An inductive method aims to create understanding through data collection and analysis (Flick, 2009, p.121; Creswell, 1998, pp.14, 15). A balance between pre-knowledge about the field and openness of mind is required (Flick, 2009, p.12, 15).

The research is also a case study (Yin, 2014, pp.5, 6; Creswell, 1998, p.61; Flick, 2009, p.134) of engaging different groups in the process of designing and constructing a demonstration sustainable building within the framework of introducing and promoting environmental knowledge and practices.

5.3 Research methodology

Niedderer and Roworth-Stokes (2007) found design research is characterised by a number of approaches. According to Feast and Melles (2010), one approach often used in design research is that of Crotty (1998, p.2, 3) who frames the research process in terms of four basic elements: epistemology (theory of knowledge), theoretical perspective (philosophical stance), methodology (strategy behind choice of method(s), and methods (techniques for data collection and analysis). Figure 5.1 sets out Crotty's approach and its application in this research.

Figure 5.1 Crotty's four-element research approach (left) and its application in this research (right). Source: Adapted from Crotty, 1998, p.4

5.3.1 Epistemology and theoretical perspectives

Based on Crotty's (1998) approach, Feast & Melles (2010) developed a knowledge framework (Figure 5.2). The epistemological stance for the thesis is mainly constructivist, and to a lesser extent objectivist. For the former a sustainable building could be seen as the development and communication of design knowledge (Cross, 2001). The design of a sustainable building could also be seen as a *reflective practice* (Feast & Melles, 2010), which only constitutes research if "it is also accompanied by reflection upon the process of making" (Cross, 2001). The

objectivist position emphasises the logical construction of theories based on discrete empirical facts (Friedman, 2003), suggesting knowledge about sustainability is articulated through systematic inquiry,

Epistemology	Theoretical Perspective	Methodology	Methods
Constructivism	Interpretivism	Action research	Qualitative (Focus groups/ interviews)
Objectivism	Positivism	Survey research	Statistical analysis (Surveys)

Figure 5.2 Research methodology based on Crotty's (1998) knowledge framework.
Adapted from Feast and Melles, 2010.

In Figure 5.2, *interpretivism* is associated with the constructivist epistemological stance, which involves understanding process and interpreting elements of the study (Denzin & Lincoln, 2011, p.92), while *positivism* is associated with the objective epistemological stance that recognises what can be scientifically verified or is capable of logical or mathematical proof (Macionis & Gerber, 2010), thus using reliability and validity as an approach to knowledge (Denzin & Lincoln, 2011, p.91). Groat and Wang (2002, p.30) argue that in an interdisciplinary field, such as architecture, there is a need to highlight the vital link between theory and method. Therefore, elements of constructivist and objectivist epistemological stances should be present.

5.3.2 Methodology

Each of the two theoretical perspectives employed in this research requires a particular research methodology (Grotty, 1998, pp. 2, 3). An interpretivist stance places particular emphasis on the role of the researcher as a vital part of the research outcome, thus suggesting 'pure objectivity' is impossible (Groat & Wang, 2002, p.88; Feast & Melles, 2010). In this research the interpretive stance can be linked to *action research* (Figure 5.2), which involves the researcher "participating with societal members to produce social change or implement a social policy or organised response to a problem" (Denzin & Lincoln, 2011, p.583). In this methodology the research process is one where action and research are integrated

(Elfors & Svane, 2008, p. 2). In this case, the research knowledge gained from the demonstration project could be a tool for change where the researcher is the facilitator. In the same way, the development of the building allows the researcher to explore and evaluate its impact in addressing problems related to pro-environmental behaviour. The research model permits reflection, sharing practical knowledge, and dissemination of information with the participants, with the researcher balancing between the roles of researcher, team member, and teacher.

Concerning the positivist stance, the study uses *survey research* and quantitative methods of statistical analysis to determine the effectiveness of the research project as an educational tool and to assess changes the visitors have made as a result of their visit to the demonstration building.

5.4 Research methods

This section describes the two main methods used in this thesis, namely *focus groups/interviews* and *surveys*. Groat and Wang (2002, pp.30, 31) argue that quantitative and qualitative methods are characteristic of architectural research. Here the focus group discussions and interviews are largely qualitative and the survey largely quantitative.

5.4.1 Case study

Creswell (1998, p.61) defines a *case study* as “an exploration of a *bounded system* or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in context.” Case studies are often used in education and psychology (Yin, 2014, p.229), and also in architectural research as “an empirical inquiry that investigates a phenomenon or setting” (Groat & Wang, 2002, p. 346).

Figure 5.3 Basic types of designs for case studies. Source: Yin, 2014, p.50

Yin (2014, p.50) distinguished four design types of case studies (Figure 5.3) with the selection dependent on the theoretical proposition of the study. Given the primary purpose of this thesis is to examine the effectiveness of demonstration projects in influencing pro-sustainable attitudes, an embedded single-case study will be used (Type 2 in Figure 5.3), which implies a number of studies conducted from a holistic perspective. These will involve the various actors engaged in the demonstration project at different stages of the building process. These include project designers, sponsors and building material suppliers, builders and trades people, graphic designers, management, and visitors (Figure 5.4). The investigation can be described as an iterative process between literature studies, data collection and analysis, and reflection.

Figure 5.4 The multiple-case study research plan.

As the sustainable building project yields a chronology of events, the multiple sources of data are analysed to determine evidence for each phase in the evolution of the project (Creswell, 1998, p.153).

Research project actors							
Project process stages	Concept designers	Sponsors	Builders	Helpers	Graphic designers	Management	Visitors
Design	B				B		
Building		A	A	A		A	
Demonstration							C

Figure 5.5 Research methods for project actors at different stages of the building process.
A = Interviews, B = Focus group discussions, C = surveys.

This research is an embedded case study consisting of three separate studies based on the project stages; design, building, and demonstration (Figure 5.5). These provide different perspectives on how a sustainable building can influence the

values held by the various actors who interact with it. The use of multiple empirical sources and methodologies improves the validity of the findings (Groat & Wang, 2002, p.30).

5.4.2 Qualitative data

Interviews and focus group structured discussions are one of the most important sources of case study evidence and these play a central role in this investigation. The framework for conducting these and the variables investigated for each specific group of actors are discussed in Chapter 7. The background to the instruments used for investigating values, attitudes and behaviour can be found in Sections 3.1.1 and 3.2.

The research employs a series of *individual interviews* and *focus group discussions* at different stages of the project, as appropriate. Participants were involved in either type both pre-engagement and post-engagement in order to observe whether engaging in the project had any influence on their attitude, or their behaviour towards sustainability.

Krueger and Casey (2009, pp.67. 68) discussed the recommended size of focus groups, stating “Traditionally, the recommended size within marketing research is 10 – 12 people. However, for most non-commercial topics the ideal size of a focus group is 5 – 8 participants.” Focus groups in this research comprised 6 student designers (see Section 7.1.1.1) and 7 student graphic designers (see Section 7.1.3.1).

5.4.3 Thematic analysis

Thematic analysis was employed to identify patterns and themes within the qualitative data (Guest, 2012, p.11; Braun and Clark, 2006). Besides organising and describing the data, the method allows for interpretation of aspects of the research topic (Boyatzis, 1998, pp.144–146). As a process, thematic analysis is performed through six phases to create established, meaningful patterns. These are familiarization with data, generating initial codes, searching for themes

among codes, reviewing themes, defining and naming themes, and finally producing the final report (Braun & Clarke, 2006).

5.4.4 Quantitative data

Statistical analysis of surveys provides quantitative or numeric description of the trends and attitudes of a sample. Potentially surveys have a larger number of participants compared to individual interviews (Creswell, 2009, pp.12, 145, 146). Consequently, surveys are used in this research for studying visitors to the finished demonstration building. Additionally, all participants were given a pre and post-survey on attitudes so that conclusions could be drawn about the effectiveness of the research project in changing these.

5.5 Summary

This chapter outlined the methodological and research approach, the research design and the methods to be used in the empirical studies. The research approach is explorative, predominantly making use of qualitative methods. The investigation process can be described as iterative between literature reviews, data collection and analysis, and reflection. Sample size was a determining factor in selecting the appropriate approach for this research.

Before describing the data collection and analysis in detail in chapter 7, the history of the LCP is set out in chapter 6.

Chapter 6: The Case study

“To us, the word sustainable means that we will live in the centre of Sydney producing water, energy, and waste water in a way that sustains our life physically and financially.”

Michael Mobbs (Sustainable House, 1998, p.12).

This research is an embedded case study (Section 5.4.2) with the empirical material consisting of three separate sets of studies based on the project process stages of design, building, and demonstration. These provide different perspectives on how a sustainable building can influence the values held by the various actors who interact with it, and how this can inform and enrich the empirical basis for a discussion. The use of multiple empirical sources and methodologies improves the validity of the findings (Groat & Wang, 2002, p.30).

6.1 Aim of the building project

The aim of the study is to teach the local population about sustainable living practices through engaging in a demonstration project for sustainable building (see Section 1.2.1). This includes the process of creating a demonstration project, *what* can be learnt and in what way this example has contributed to inspiring the behaviour of those who come in contact with it. It is also about exploring *how* to study and exhibit a sustainable building in order to make the information useful to others thinking about small building refurbishment. Acknowledging this, the case study is conducted with an outcome and a process in mind.

Gehry stated, “Architecture should speak for its time and place, but yearn for timelessness” (Seferin, 2010), subsequently any architectural project is bound by its context. Hence, the building process influences the way the building is

designed and vice versa. Beyond this, making sense of sustainable design in architecture tends to be confusing given the quantity of information on the subjects of green and sustainable buildings (Guy & Farmer, 2001). The difficulty of designing a demonstration facility arises when specific solutions from a case are applied to another project, or to another process, where the conditions are not the same. In order to create useful models, elements specific to each case should be distinguished from what is generally applicable. Furthermore, it is important to consider the purpose of the LCP being both a demonstration and a residence.

6.1.1 A building as a demonstration facility

A demonstration sustainable building could be as a means of showing sustainable construction and an effective tool to bring about change in user choices and behaviour (SCMT, 2004, p.14; IEA SCH Task 40, 2012, p.1; USC, HR6, 2007, Sec.491). From Section 3.5, demonstration buildings have been used to show the interaction between building projects and the human environment in a number of countries (Daly, 2008; Dietz et al., 2009; Vale & Vale, 2013, p.262). *Good examples* are needed in all aspects of the built environment, including retrofitting, refurbishing, and renovation, as well as new buildings (SCMT, 2003, pp.10, 14). Given this, the LCP is an opportunity to conduct such a project in New Zealand.

Hence, this study aims to create an exemplar of sustainable practices through a demonstration building by means of refurbishing the LC at Otatara. It also explores the relevance of this demonstration project in terms of what can be learned and whether the project can become an educational tool and a catalyst for the community to inspire sustainable attitudes and practices. Accordingly, studies are conducted at the design, construction, and demonstration stages of the project.

The study also explores, through a student project, the manner by which information can be exhibited to communicate sustainable concepts and practices clearly and usefully.

6.1.2 Rationale for a residential building

Primarily, the purpose of the building project is the public display of sustainable practices in refurbishing and running a small building. In order to make it relevant to the majority of visitors the building is designed as a residence. In the past the LC was an artist-in-residence space. However, from a practical point of view, permanent occupancy of LC would affect its availability and readiness for use for its main purpose as a demonstration facility for sustainability (see Section 6.9.4).

6.1.3 A building as a refurbishment project

This study aims to develop techniques and methods to maintain, refit, and refurbish the existing LC to become an educational tool and a facility for showcasing sustainable construction practices and techniques. The SCMT Working Group Report (2004, p.10) stated there is not one universal *recipe* for achieving more sustainable construction as appropriate techniques are related to and influenced by factors such as use, culture, climate, and resources.

6.1.4 Significance of the social dimension

In analytical studies of buildings, the focus is often on the object/process relationship, namely on the building itself and the process behind its realisation (Granath, 1998, p.152; Teymur, 1982, p.5). The aim here is to create a facility that considers the needs of the widest range of viewers (with respect to age, gender, income, and ability), which suggests having more general solutions. Problems can arise when specific solutions from a particular project are applied to another project where the conditions are not the same.

The SCMT Working Group Report (2004, pp.10, 15) stated performance parameters critical for people's quality of life are not easily quantifiable, but include factors that can motivate people to care for their environment, such as cultural expression and cultural identity, integration into the existing urban and natural context, and attractiveness (Bahho, 2013).

6.2 Setting up the Log Cabin Project

Sustainable building practice is a set of environmental, technical, social, and ethical issues with the general objective of reducing human impact on the earth. A project strategy was first established to create a framework for refitting and refurbishing the LC at Otatara.

6.2.1 Formal approvals for the project

Since the building is part of the Eastern Institute of Technology (EIT) campus, formal authorization to undertake this research had to be sought. In May 2012 permission was granted to develop the LC to become a demonstration facility for sustainable building, with the condition the development would be at no cost to the institution. Also, as the Otatara site holds special historic, cultural, and spiritual significance to indigenous Māori of New Zealand (Sections 2.4.8 and 2.4.9) their approval had to be obtained. In May 2012 this was granted locally from both Waiohiki Community Charitable Trust and Waiohiki Marae Trust (Appendix 2).

6.2.2 Project design team

Because the LC was intended to be a catalyst to inspire people's pro-environmental behaviour (Section 3.3.1), it was decided that the concept for the project's refurbishment would be generated and developed by students at EIT. Eventually these students would become an important part of the research investigation.

Thus, rather than supplying a brief for the project retrofit, this was to be discussed and generated by a group of Second Year students in the EIT Visual Arts and Design (VAD) programme as part of a Design Studio course. The educational aim was to adopt a reflective teaching method that would enable meaningful learning (Smith et al., 2009). To facilitate working with a group of students who want to influence behaviour through design (Tromp et al., 2011; Wilson et al.,

2013), the need for responsible environmental attitudes to manifest the context of sustainability and ecology through design was discussed, coupled with applying *design thinking* in dealing with environmental, social and ethical issues in addition to the technical and architectural context (Dorst, 2011).

Nineteen design students were invited to take part in formulating the initial concepts and six opted to become involved, with the remainder choosing to work on other projects for various reasons. However, all design students undertook the surveys on attitudes to see if there were any differences in the values held by students opting to engage with the project. Details of this student group are set out in Table 6.1, which also includes details of another student group, the student graphic designers, later involved in the project (Section 6.9.1).

		Project Concept Design		Project Graphic Design	
		Design group (N=19) ⁽¹⁾	Participants (N=6)	VAD group (N=25)	Participants (N=7)
Gender	Male	5	–	7	2
	Female	14	6	18	5
Ethnicity	Maori	2	2	5	1
	Pacific	–	–	2	1
	Islander				
	European	17	4	17	4
	Other	–	–	1	1
Age	17–25	11	3	20	7
	26–40	6	2	2	–
	41–50	2	1	3	–

Table 6.1 Summarised details of students in the concept design and graphic design of the LCP.

⁽¹⁾ N = number.

Consideration was given to writing the project brief criteria so that they would fit with the teaching curriculum in terms of timeline and learning outcomes.

6.2.3 Aims and guideline for students

In response to the educational context, the integrated and interactive model adopted in the design studio aimed to address the demands of the project, while enabling specific and meaningful generic learning. The teaching model was outlined by defining the learning strategy and describing the structure and content of study (Smith et al., 2009).

At the beginning, the students were presented with a *guideline brief* for the Design Studio module (Appendix 3). The brief outlined the *project's objectives* of designing a demonstration facility for sustainable building, a task that “involves refurbishing the existing log cabin at Otatara Hill (part of the EIT campus) in order to improve its sustainability.” As mentioned before, for the majority of visitors to relate to the building’s systems and practices, it had to function as a residence. The *design philosophy* was also explained in terms of aiming for a Net ZEB building through integrating renewable low energy design (Section 4.2) with low environmental impact materials (Section 4.3), as well as looking at passive solar standards (Section 4.4). The UK’s CSH was the benchmark for overall building performance (Section 4.1.1). The brief also included a list of *environmental topics* to be explored. The project approach incorporating the teaching stages of the module was explained (Figure 6.1). The students were also advised of being involved as actors in the research project.

Figure 6.1 Flow diagram of the LC concept design process.

Using the parameters identified, the students were given a project timeline (Table, 6.2).

Weeks	Period	Activity
29, 30	16 July – 27 July	Stage 1: Research
31, 32, 33	30 July – 17 August	Stage 2: Design Concept – preliminary
34, 35	20 August – 31 August	Stage 2: Design Concept – presentation
36, 37, 38, 41	3 Sep – 21 Sep	Stage 3: Development design-preliminary
42, 43, 44	8 Oct – 2 Nov	Stage 3: Development design – final presentation

Table 6.2 The 2012 project brief timeline.

6.2.4 Project brief guideline basis

At the beginning in July 2012, the students were presented with a set of aims and guidelines for the building refurbishment. These were established by comparing standards and recommendations from a number of national and international sources in order to find out what characterizes a sustainable building (see Section 4.1). Reference was also made to what defines a ‘sustainable building’ (Section 2.3.7).

A design strategy was then established for the LC guided by the philosophy of integrating renewable low energy design with low environmental impact of materials, aiming to achieve a Net ZEB (Section 4.2.1), noting that NZ electricity was 75% renewables in 2013 (MBIE, 2015), using recycled building materials and components, and reducing mains water use and burden on existing infrastructure through collecting rainwater and treating wastewater. The challenge to the students was to integrate these approaches and consider the environmental impact of materials. The results would be checked against passive solar energy targets (PHINZ, 2014) and the renewable energy systems production checked against modelled consumption once a design was established.

In relation to specification of sustainable materials, the student designers looked at sources including the Building Research Association of New Zealand (BRANZ) and the Building Research Establishment (BRE) in the UK, for guidance. They were also to refer to CSH as a guide to overall building performance (CLG, 2006) and CO₂ emissions reduction (Sleeuw, 2011, pp.8, 9).

6.3 Project design criteria

Using the parameters identified, the LCP brief was discussed with the students and the following aspects were explained as part of the data collection and analysis stage (Bahho & Vale, 2017a). These aspects were first examined separately, although recognising there will be inter-actions.

6.3.1 Indoor thermal comfort

Discussions explored sustainability in relation to the relative concept of *comfort*, whether thermal or psychological (Heschong, 1979). Szokolay (1983, p.328) described the feeling of comfort as experiencing no stress and feeling comfortable with the conditions. Comfort indices combine the four variables of temperature, humidity, radiation, and air movement, as well accounting for the influence of clothing, metabolic rate, and a range of subjective factors. Eventually, a consensus was developed in which dry bulb temperature alone was accepted as a criterion for comfort provided that the other three variables were within acceptable limits (Szokolay, 1983, p.328).

It was important that the retrofitted building recognise its NZ situation. NZ houses are not centrally heated and Napier has high winter sunshine hours so that outdoor living is possible on a sunny day in winter. There is also a cultural tradition of wearing more clothes rather than heating (Cupples et al., 2007). Recognising that comfort is a psychological state (Heschong, 1979) this is possible in a house heated locally in NZ because culturally this is acceptable.

Considering the design criteria for energy in the LCP, adopting passive methods offered a sustainable way of minimising the energy demand of the building while

improving the comfort level experienced by the occupants because of the energy stored in internal mass. In theory passive solar design and high thermal mass make it is possible to meet remaining energy demands entirely from renewable sources (Feist et al., 2007, P.7) (Section 4.3). For the LC combining passive solar techniques and active renewable energy should significantly reduce annual space heating requirements (Feist et al., 2007, P.7; Müller & Berker, 2013) (Section 4.3). This approach was thought appropriate for a demonstration on minimizing domestic energy. However, the students had to deal with the fact the LC might be less than optimal in terms of orientation, thermal mass, and weather tightness due to its being an existing building (see Section 4.3).

6.3.2 Passive solar design

The aim with the LC was to use passive solar design principles (Section 4.4) to reduce energy demand whilst recognising that the nature of the structure was not ideal for these (Müller & Berker, 2013).

6.3.3 A Net Zero Energy Building

The aim was to utilise renewable energy leading to a Net ZEB (Section 4.2). For NZ Jaques (2014) stated a Net ZEB is one connected to an energy infrastructure so that surplus energy production in one season can offset later energy use on an annual balance (see Section 4.2.1). This made Net ZEB the preferred approach since the project was to be a demonstration building for the local community, where most houses are joined to the electricity grid. The goal became that of calculating the size of the renewable energy system such that annually feeding into and taking electricity from the grid is in balance (Torcellini et al., 2006).

6.3.4 Impact of materials

The essential concept of a ZEB is one with reduced energy requirements not just for operation but also for building materials and services. This means calculating the energy embodied in the building's construction, leading to a life-cycle methodology calculation (LC-ZEB) (Section 4.2.3). At the moment LC-ZEB calculations are difficult for people both to conceptualise and do (Hernandez &

Kenny, 2010). However, the students were to consider embodied energy through choice of materials and recycling (section 6.3.5).

6.3.5 Materials and recycling

Given that buildings have a relatively long lifespan compared with other things necessary for daily life, such as furniture, it was necessary to focus on the refurbishment and refit practices and their impact on the built environment (UNEP, 2003, pp.5–6; SCMT, 2004, p.10). Brand (1994, p.17) confirmed that having longer life-cycle span, structure and building skin layers influences how materials are understood (Section 2.2.5). The students thus talked about reuse, using materials with lower impact, and designing for reuse or recycling at the end of the building's life (Graham, 2003, p.26). The CSH also recommended thinking about the life-cycle of building fabric components including considerations of embodied energy and design for reuse and recycling (CLG, 2006, pp.8, 9).

Sartori and Hestnes (2007) investigated the potential of recycling for reducing embodied energy requirements by widening the boundaries of analysis from cradle-to-grave to include the recycling phase. In a retrofit building like the LC, using recycled materials and components could be significant in reducing the embodied energy of materials, so this became the aim.

6.3.6 Wastewater and sewage treatment

Discussions looked at the cradle-to-cradle design approach for buildings with the aim of trying to eliminate waste rather than reduce it (McDonough & Braungart, 2003). It was decided the LCP would be equipped with means to treat both grey and black water (sewage) and to reuse the result for toilet flushing, or watering plants on site.

6.3.7 Water conservation

UNDESA (2010) outlined the need to capture and reuse storm water runoff to reduce consumption of potable water, as well as the energy and CO₂ emissions associated with mains water. It also supported the recycling and reusing of wastewater after treatment as a low energy source of water supply (UNDESA,

2010, Ch6, p.8). Attari (2014) found that participants mentioned curtailment (short showers and rationalizing water use) rather than efficiency improvement (replacing toilets and washers) as effective strategies to conserve water.

In the case of the LCP, the rainwater from the roof would be collected and stored and used for drinking and washing.

6.4 The project brief

In July 2012, the students worked as a group to formulate a project brief and to establish a framework for refitting and improving the LC to become a demonstration sustainable building (Section 1.2.1) (Bahho et al., 2015; Bahho & Vale, 2017b).

6.4.1 Research and data collection

Based on the design criteria explained in Section 6.3, the purpose of the design brief was to enable the student designers to create a concept for refurbishing the LC and document this. The intention was to think of and deal with the fundamental issues of how the building could be constructed and to think about how those who live in such buildings should operate them. These views were enhanced during the studio sessions through showing a series of sustainable building projects, such as Roaf's Oxford House, 1995 (Roaf et al., 2001), Vale & Vale's New Autonomous House, 1993 (Vale & Vale, 2002), and Thomas Herzog's Housing Development Project in Munich, Germany, 1982 (Ingeborg et al., 2002) and talking about how the architects' views might have influenced the project.

6.4.2 Updating guideline topics

In the process of formulating the project brief, and based on CSH, the students were asked to discuss and explore sustainable practices applicable and suitable for the concept design. Each student was asked to gather and analyse information on one specified research topic chosen from indoor thermal comfort, passive design, Net ZEBs, impact of materials, recycling, wastewater and sewage

treatment, and water conservation. Two students looked at the first three topics because of their interrelated data and complexity leaving the other three to one student each to investigate.

As a result of the data analysis and conversations, the students decided to update the classification of topics given in the project brief guidelines. Indoor thermal comfort (Section 6.3.1) and passive solar design topics (Section 6.3.2) were combined into an *energy conservation* category and a *renewable energy systems* category was introduced to complement the Net ZEB energy objective. They introduced a *healthy indoor air* category to include natural lighting and ventilation as well as material toxicity, and a *sustainable landscape* category. The focused environmental themes and their categories are shown in Table 6.3 and compared with the CSH criteria.

Category	LC Project Brief Requirements	CSH Standards
Energy conservation	To utilise solar design for passive heating and cooling, as well as making use of natural lighting and ventilation.	A 'zero carbon home'* is rated at 6-Star level (heating, lighting, hot water, and all other energy uses in the home) (CLG, 2006, p.10).
Renewable energy systems	To include solar photovoltaic systems, solar hot water heating systems, and eco types of electric lighting and Energy Star appliances.	
Impact of materials	To consider embodied energy of materials used for framing and finishing.	The total building points under CSH material calculator achieve the score of 15 points. Scores are added for; roof structure and finishes, external walls, floors, internal walls, and windows and doors (CLG, 2006, p.16).
Materials recycling and reusing	To use recycled materials and building components in the retrofitting, such as window joinery, and bathroom fixtures and fittings.	
Wastewater and sewage treatment	To recycle grey water and to treat black water.	On-site treatment of solid waste from the building (CLG, 2006, p.11).
Water conservation	To save rainwater by storing the roof runoff	Internal potable water consumption is less than 80 litres per person per day (CLG, 2006, pp.10, 15).
Healthy indoor air	To consider achieving minimum average daylight and ventilation factors. To include the use of low or no-VOC paints, durable and formaldehyde-free materials.	To meet the minimum standards of daylight (CLG, 2006, p.21)
Sustainable landscape	To include the use of drought tolerant plants, and high efficiency irrigation system. To consider including a glasshouse to grow veggies all year round.	Not included in CSH, added specifically to the project.

* The terms zero carbon and zero energy are interchangeable in their application to define buildings with very high-energy efficiency ratings (EPBD, 2011, p. 7).

Table 6.3 LC project brief category requirements compared to CSH criteria.

6.5 The project concept design

An integrated and interactive model was adopted in the design studio aimed at addressing the demands of the project while enabling student exploration. The teaching model was outlined by defining the learning strategy and describing the structure and content of study (Bahho & Vale, 2017b).

6.5.1 The learning strategy

Through the design studio, the students were exposed to a number of experiences that focused on two areas. The first was ‘how to design’, introduced by engaging with the design process within the generic framework of analysis, synthesis, and evaluation. The second was to reveal knowledge about aspects or situations through the act of designing. So the emphasis shifted from facilitating an understanding of design and designing to focusing on the ability of design to reveal new understandings of ecological and sustainability issues. The latter included giving consideration to social issues (Bahho, 2013).

As all students in the group would have experiences of the built environment as users, their understandings and everyday experiences were used as a starting point, through studio discussions, to inform what was to be designed, its effects on the relationships between people and the environment, and the associated design processes. To an extent this part of the learning experience also occurred in the focus groups, although the objective of these was to understand the attitudes and values of the students.

6.5.2 Learning structure and content

The studio format can be described within the three key areas of class organisation, establishment of key design concepts as core content, and supporting resources and documentation.

The class organisation demanded a less formal and more collaborative approach considering the small student group, in a responsive and flexible environment. The content material was delivered in a design studio setting rather than formal

lectures. Two weekly sessions broken down to three hours of crits and six hours of tutorials formed the teaching and learning framework of the project design. The last three hours of tutorials were dedicated to forums and workshops to discuss, resolve, and consolidate a number of issues related to the project design, so that students would have a holistic understanding of the issues being explored.

The content was driven by themes intended to introduce relevant design knowledge and skills as well as to develop a designerly way of thinking. The content was delivered within three interactive components. The first was the *context* component, which introduced the importance of ecological considerations and addressing environmental issues through design in relation to the built environment. These ideas were discussed during consolidation sessions in the afternoon tutorials. The student group sat with the author, who was the main lecturer, to discuss and resolve various aspects of the building design in a workshop setting. This was intended to widen the ideas, for discussion of relevant issues and concerns, and particularly for performing project-related calculations. The *process* component consisted of exploring techniques and issues of design thinking by introducing relevant theory focusing on the process, not the completed work. It was delivered as part of the crits and during the morning part of the tutorials focusing on the building project solutions and what skills were needed for designing the building refit. Finally the *communication* component introduced a variety of techniques of visual communication in the context of design language. These skill sessions were also delivered during the afternoon part of the tutorials

The core resources and documentation supporting the project design activities were recorded in the studio workbook in three areas. The first, *design guidelines and criteria* would enable the students to commence the project design work. The learning occurred through focused engagement with the resource material that had to be selected, reviewed, and interrogated critically through the design activities. *Documentation of processes* including all exploratory and reflective work in response to the activities related to the project. This enabled the students to externalise

their processing and, subsequently, to allow both students and staff to use it as a basis for reflection and evaluation. The *visual diary* was a vehicle to record and critique issues related to the project graphically, through which students could develop skills in drawing and visual representation.

6.5.3 Project design concept

During the design concept stage (Stage 2), the students visited the site and analysed the building and its surroundings (Figure 6.2). Later, each student investigated and initiated a personal concept for the refurbishment. Concurrently, pre-engagement focus group interviews for the students involved in designing the project concept were conducted (Section 7.1) (Bahho & Vale, 2017b), and surveys for the whole design student group completed.

Figure 6.2 Students' site and building visit at the research stage.

The students went to various sources for information and inspiration. In addition, they were presented with lectures covering fundamental concepts of sustainable design including relevant examples. They were referred to particular library and online resources³. A trip to the First Light House in Waimarama,

3

Kwok, A. & Grondzik (2007). *The green studio handbook: Environmental strategies for schematic design*. Oxford: Architectural Press.

Lehmann, S. & Crocker, R. (Eds.) (2012). *Designing for zero waste: Consumption, technologies and the built environment*. London & New York: Earthscan

Mithraratne, N., Vale, B., & Vale, R. (2007). *Sustainable Living: The role of whole life costs and values*. Oxford: Elsevier.

Reardon, C. (2005). *Your home: Design for lifestyle and the future. Technical manual*. Canberra: Australian Greenhouse Office.

<http://www.yourhome.gov.au/>

Wilhide, E., (2002). *Eco: An essential sourcebook for environmentally friendly design and decoration*. London: Quadrille; New York: Rizzoli.

Hawke's Bay, was organised. The house was designed and built as part of the Victoria University of Wellington's School of Architecture syllabus for the 2011 Solar Decathlon competition (VUW 2011). Figures 6.3 and 6.4 show one student concept stage submission.

Figure 6.3 An example of one student concept design submission.

Figure 6.4 The presentation of the student concept shown in Figure 6.3.

Yeang, K. (2008). *Ecodesign: A manual for ecological design*. Hoboken, N.J.: Wiley.

6.5.4 Student designers pre-engagement focus group interview

At this stage of the design, the first design student focus group was carried out. This and analysis of the results is described in detail in Section 7.1.

6.5.5 Sustainable building practices, considerations and solutions

The intentions of the project were to find solutions and techniques for sustainable building practices that would be *generic* and easy-to-apply, so as motivate visitors to adopt environmentally responsible improvements in their homes. The topics developed by the students and noted above are described in more detail here. The related discussions took place in Stage 2 and continued in Stage 3, the development stage of the project.

6.5.5.1 Energy conservation and renewable energy systems

For passive solar techniques, studio discussions focused on improving the thermal insulation and airtightness of the building and evaluating this with the BRANZ Annual Loss Factor (ALF) tool for calculating the energy performance of a New Zealand house (Bassett & Stoecklein, 1998). As a result, students decided on a layer of R-2.8 m² °C/W roof insulation and R-2.2 m² °C/W wall insulation within an additional internal timber frame to the external log wall. The uninsulated concrete slab presented a problem. Ideally its mass should be part of the passive solar design (BRANZ, 2013, p.7) but not without insulation. Rather than digging up and relaying the slab the students proposed a thin layer of R-1.3 m² °C/W under floor insulation with a tile finish so as to use as much of the existing building as possible.

Furthermore, the students suggested adding a ‘greenhouse’ to the existing structure, facing north so the direct solar gain would heat the air, which would be vented by convection into the interior living space (EECA 1994, p.203; Gong et al., 2012; Kachadorian, 1997, pp.138–143). Gong et al. (2012) were quoted in the discussion, “the sunroom enlarges the insulated effects for cold and mild areas because the heat can be transferred into the space and re-radiated, can be stored for sunless hours, and keep the indoor temperature very stable” (Section 4.4). The

concrete floor of the greenhouse would be an additional thermal mass in the building. The floor would receive direct sunlight in the colder season and would warm the air that could be vented into the living space, similar to the Trombe wall technique (EECA, 1994, p.204; Kachadorian, 1997, p. 15).

The Required Heat Energy (RHE) for the LCP design was compared to the Passive House Institute New Zealand (PHINZ) standards and also to average New Zealand home energy use from the New Zealand Home and Energy End-use Project (HEEP) (Isaacs et al., 2010) (Table 6.4). Getting the RHE of the LC design close to the Passivhaus energy demand specifications was significant especially considering the LC is a retrofit project. The proposed design easily complied with Clause H1 of the NZBC, with a Building Performance Index (BPI) of 0.85 kWh/ (m². °C. month) compared to the required 1.55 kWh/ (m². °C. month).

Building	Heating Energy demand (kWh/m ² year)	Results
Log Cabin Project	16.52	ALF calculates the LC requires 1,203 kWh/year of heating energy for the total area of 73 m ²
Passivhaus	15	A certified Passivhaus has to meet a specific space conditioning demand of not more than 15 kWh/m ² year (PHINZ 2014).
Typical NZ house	28.94	Average energy use in a typical NZ house of 132 m ² is 3,820 kWh/year (Isaacs et al. 2010).

Table 6.4 Comparison of expected Required Heat Energy (RHE) in LC with other values.

A solar photovoltaic panel system to generate an average daily 2.7kW is required. According to BRANZ (n.d., p.6), 6m² of PV array is needed per kW installed for the crystalline modules, usually between 1–4 kWp in capacity (Figures 6.6 and 6.7). Hot water was intended to come from a redundant evacuated tube collector solar hot water system relocated from the Caretaker's House on EIT campus. To maximize energy savings, students suggested using power efficient Energy Star®

rated appliances and installing energy saving Halcium LED lights throughout, although maximum use would be made of daylight (see Section 6.5.5.5). Being an existing building, window size and orientation were already determined. Improving the thermal performance of the windows together with lighting and ventilation was discussed in the studio. Table 6.5 summarises windows and their orientation.

Window	Type	Orientation	Considerations and solutions
Ground Floor, Living Space, 31m ²			
W.1. 1660x1260mm	Fixed	North	Single glazing maintained. Limited heat loss as within the greenhouse addition. Ventilation provided.
W.2. 1480x1440mm	Fixed	West	Afternoon sun obscured by the hillside. Double glazed to improve thermal performance.
Ground Floor, Proposed Bathroom, 5.50m ²			
W.4. 1740x820mm	Fixed	East	Double glazed to improve thermal performance.
W.5. 820x660mm	Awning	South	Double glazed to improve thermal performance.
First Floor, Bedroom Space, 24m ²			
W.9. 1450x1000mm	Double casement	North	Double glazed to improve thermal performance.
DW.10 1200x1760mm	French door	South	Double glazed to improve thermal performance.

Table 6.5 The LC window sizes, types, and orientation, with considerations to improve thermal performance. For window location match window number with Figure 6.4

The students' design thus incorporated natural heating and ventilation without mechanical systems with the aim of achieving near zero carbon emissions, see Figures 6.5 and 6.6.

Figure 6.5 The combined student concept design, ground floor plan.

Figure 6.6 The combined student concept design, first floor plan.

6.5.5.2 Sustainable building materials and techniques

Timber, as a renewable structural building material with low embodied energy (Sustainable Design Award 2004), was chosen for the framing of the greenhouse

and the new internal lining to the external log walls, see Figure 6.7. The consolidation discussions fixed on this being, as much as possible, recycled timber.

Figure 6.7 The combined student concept design, longitudinal section.

Following student discussions, fibreglass Pink Batts were preferred for insulation as they are locally made and use up to 80% recycled glass (Pink Batts, 2011).

For windows, recycled timber would be used for repairs and to make them suitable for new double-glazing units to replace the single glass. Some thin window sections such as those in the bathroom and French doors, meant some could be secondary glazed without completely replacing them with new double glazed units (EECA, 2017). Recycled single glazed window frames would be used for the greenhouse walls.

The design students were careful to specify low embodied energy materials as well as recycled materials and building components wherever practical. The existing kitchen joinery would be repaired and refitted and recycled bathroom fixtures installed, including shower, basin, and toilet.

6.5.5.3 Sewage and wastewater treatment

Low-flow toilet fixtures and aerators were discussed as a means of saving water, although these are initially expensive. The group discussed trying to find sponsors

who would be keen to provide the products and showcase them to the public, or sourcing a recycled toilet, shower, and washbasin. Eventually, the second option was adopted. A similar discussion occurred over finding a washing machine between the preferred low star rated appliance for its low water usage and energy saving and a recycled option should the new one be unaffordable.

Figure 6.8 The combined student concept design, site plan.

The students suggested using a sewage and wastewater treatment plant. The recycled effluent would be used in the greenhouse and excess discharged to a nearby drip-line effluent field (Figure 6.8). Studio discussions found all types of sewage treatment plant had positive and negative points. Bio sewage systems that use worms and other organisms would be organic but were not suitable for low occupation or intermittent use. On the other hand, a septic wastewater treatment plant could handle low flow rates but would need a small pump to reuse the treated effluent. However, this could be added to an existing septic tank, hence making it suitable for demonstrating what people could do at home. The chosen system consists of a separate settlement tank followed by the sewage treatment plant with a capacity of 1500 litres/day, thus fulfilling the BS 5906 minimum

requirement of 0.8m³ (or 800 litres) per dwelling (CLG, 2006, p.11), see Figure 6.8.

Capillary mats were proposed as an effective irrigation method to rationalise the use of treated wastewater in the greenhouse (Paparozzi & Meyer, 2012; Deep Green Permaculture, 2013).

6.5.5.4 Water conservation

Roof runoff would be stored in a 10,000-litre rain storage tank and used for drinking, cooking, and washing. The students used a Water Consumption Calculator to find the annual water consumption of 48,358 litres (CSG Network, 2012). As the mean annual rainfall in Napier is 786mm (NIWA, 2013, p.19) and the roof area 89m², the total runoff water is 41,552litres⁴ (Waitakere City Council, 2009, p.11). The balance of water needed would come either from savings in use or using the existing mains water connection (Figure 6.8).

A retaining wall was proposed at the eastern side of the building to mitigate the risk of flooding by channelling the surface water away from the building.

6.5.5.5 Healthy indoor air

Discussions revolved around natural ventilation and eliminating building materials containing toxic substances to achieve healthy indoor air.

During consolidation sessions, desktop calculations were carried out for each room to estimate the level of natural light. As a rule of thumb, a room has a day lit appearance if the glazing area is at least 4% (or 1/25) of total room surface area (areas of floor, walls, and ceiling) (DETR, 1998, p.7). Similar rules apply in New Zealand Standards (AS/NZS 1680.1 2006, pp.76–78) (Table 6.6).

⁴ The amount of runoff water that could be collected in a year could be calculated as follows: Total water (litres) = Roof area (m²) x 0.66 x 0.9 x Mean annual rainfall (mm).

Space	Total Room Area	Window Area	Ratio (< 1/25)
Ground Floor, Living Space	100.15m ²	4.25m ²	1/23.56
Ground Floor, Bathroom	5.50m ²	1.95m ²	1/2.80
First Floor, Bedroom	85.70m ²	3.65m ²	1/23.48

Table 6.6 The LC interior space natural light considerations.

The New Zealand Building Code for ventilation requires a net opening area no less than 5% of the floor area for habitable spaces (DBH Clause 4, 2011, p.14). The total floor area for both levels of the building was 54.5m²; hence the minimum opening area required would be 2.72 m². The existing openings of 3.56m² fell well within this.

Low or no volatile organic compound (VOC) paints would be used throughout the project. Studio discussions were based around students' findings on set VOC levels of 250 grams per litre for flat paints and 380 grams per litre for other finishes (Consumer Research, 2015). Knowing the VOC level in locally produced Resene Lumbersider water-based paint was 35 grams per litre (Resene, 2014) and that Dulux could offer low VOC paint products that could achieve high Green Star requirements for buildings (Dulux, 2015), any of these products could be used.

Durable and formaldehyde-free wood-based materials and products were chosen for new and refit components. Studio discussions focused on the effects of formaldehyde as a carcinogen (IARC, 2006; NCI, 2011).

6.5.6 Judging of design concepts

The design concept stage of the project brief was completed and the six concepts were put on display (Figures 6.3 and 6.4). In order to achieve impartiality in selecting the concept to take to the next stage, the submissions were judged by an

independent team outside the teaching staff. This was a panel of an architect with experience in designing sustainable buildings, the Head of School of Arts and Design (now the ideaschool®), and the building development officer at EIT. After examining the submissions, the panel could not decide on a clear winner but opted to select favoured elements and particular solutions from individual concepts in order to form a *combined design concept* (Figures 6.6, 6.7, 6.8, and 6.9). In their feedback report the panel provided recommended criteria for the combined design concept (Appendix 4), summarised as follows:

- To be mindful of the history of the place and site.
- To fully utilise what previously exists of the log cabin.
- To maintain the integrity of the log cabin structure.
- To ensure multiple reasons for any proposed design decision.
- To pay further attention to rationalising building services.

6.5.7 Project design development

The outlines of the combined design concept were decided by the group. Stage 3 of the project brief started with each student assigned a particular part of the combined concept to explore and develop in further detail. The six topics were passive solar design, the proposed greenhouse, the kitchen retrofit, the proposed bathroom, and the interior space retrofit, as well as external works including wastewater treatment, water conservation, landscape, and exterior ground works.

Each student addressed key design targets related to their assigned task and produced a number of solutions to fulfil the criteria of the project brief (Figure 6.9). The results showed a developing sensitivity towards defining and executing the design ideas, while showing consideration for the intentions of the combined Stage 2 concept. The results arrived at by the students were specific to the LC's particular situation.

For the development work the studio delivery pattern and its associated learning strategy and learning contexts used in the earlier stage were repeated here.

Six months after the end of the LC design project, a post engagement focus group interview was undertaken and the students also completed the same three-section psychology based survey on environmental values (see Section 7.1.3) with an added section on the actions they might have performed as a result of taking part in the project.

Figure 6.9 Examples of student's work in Stage 3 showing kitchen (Top Left), bathroom (Top Right) and greenhouse (Bottom Left & Right).

6.5.8 Project refurbishment working drawings

The student's design work was compiled by the author to form the basis for a set of working drawings and project specifications. All the necessary measures were taken to ensure compliance with the New Zealand Building Code. A building consent application was made to Napier City Council and a building permit later issued to authorise the building works.

6.6 Sponsorship

As stated earlier, funds for the construction materials, equipment and labour needed, were raised through sponsorship with no cost to the institution (Section

6.2.1), due to the prior agreement. Whilst the project concept design was underway, the author formally wrote to a number of potential sponsor groups and individuals requesting their involvement.

In the beginning it was very difficult to convince the first sponsors to be involved. However, once the first couple of sponsors were secured, it was easier for others to be convinced of the value of being part of the project. This was a critical point in the building process (Bahho et al., 2016).

Fortunately, the LCP had the full support of the Trades and Technology programme at EIT with a promise of labour as part of student ‘work experience’ practice. Eventually, the project had full sponsorship backing from the following organisations:

- Independent Timber Merchants (ITM) for building materials.
- UNISON Networks Ltd. for the supply and installation of the photovoltaic energy generating system (later opting to contribute \$2000 towards it instead) and connections to the power mains.
- Gemco Group Holdings (GGH) for supporting the building works.
- Effluent Management Systems (EMS) for supplying the waste treatment plant and expertise.
- Nicolglass® for contributing to the glazing needs for all windows.
- Hawke’s Bay Regional Council (HBRC) for waving the Resource Consent fees for the wastewater system and providing insulation materials for the building retrofit.
- Napier City Council (NCC) for a \$1000 contribution towards the building consent fees
- Ideal Electrical for contributing to the electrical installation of the photovoltaic system.
- Schindler for supplying ecological lighting fixtures.
- Apricus® New Zealand for contributing to the supply of the evacuated tube collector solar hot water system (redundant solar hot water system at EIT was too large for the LC, see Section 6.5.5.1).

This research wanted to investigate why sponsoring individuals and groups choose to become involved (Bahho et al., 2015). As many sponsors as possible were interviewed using a structured list of questions and analysis and discussion of the results is in Chapter 7.

6.7 Vandalism of the log cabin

Being an abandoned and ignored building, the LC was subject to acts of vandalism. These started during the second semester of 2012, coinciding with the concept design stage of the LCP, and lasted for about eight months. The damage included smashing all window glass, breaking a couple of window frames, breaking an interior door, and denting and damaging the kitchen joinery, in addition to tagging most interior surfaces and leaving a pile of rubbish behind (Figure 6.10).

Figure 6.10 The log cabin was vandalised (left) as a result all windows were blocked (right).

To protect the building from further damage and to prevent intruders from breaking in, all windows were lined with plywood sheets and a battery operated alarm system was installed as the building was not then connected to the electricity grid (Figure 6.10). Vandalism did not stop but was less frequent. Later, after connection to the electricity grid was restored, a permanent alarm system was installed and that stopped the vandalism.

6.8 The log cabin retrofit

As stated earlier, funds for executing the building works were limited and were mostly raised through sponsorship or via contributions of individuals or groups to the building works. Therefore, the author tried on many occasions to find ways to save on building expenses, either through raising funds or seeking help through personal contacts. This prolonged the building period as the work relied heavily on availability of volunteer helpers and equipment. The phases of the project work and the groups involved are described below.

6.8.1 Preparation for the works

The first tasks included removing the topsoil and clearing the ground level around the building. This was done with help from the grounds keeper at EIT. The work also included excavating the part behind the northern wall and digging trenches for the foundations of the greenhouse with help from staff at the Trades and Technology programme (hereafter called Trades) (Figure 6.11). The Trades students also prepared the footings for the retaining wall on the western side. UNISON, a project sponsor, reinstalled the connection to the electricity grid.

Figure 6.11 Preparing the site and excavation (Left) and building the retaining wall (Right).

6.8.2 Insulating the roof

Putting insulation in the existing roof was an arduous task. The roofing had to be taken off to allow for new purlins and insulation to be installed, and the same roofing had to be reinstalled without damage. The process also required

scaffolding around the building for edge protection, so project works were delayed for a few months until the scaffolding that belonged to the Trades became available, since hiring it was unaffordable. Gemco, one of the project sponsors, helped with the work as did the Trades students under supervision (Figure 6.12).

Figure 6.12 Insulating the roof, July–September 2014.

6.8.3 Building the greenhouse

The project building works took much longer than first planned. The author realised the only way to advance the building works was through taking a hands-on approach. This was in addition to a fulltime teaching workload at EIT. The concrete floor slab for the greenhouse was laid during a three-week mid-year break with help from a retired ex-neighbour builder and two students from Trades, as part of their work experience (Bahho et al., 2016).

Figure 6.13 Different stages of the greenhouse building, July 2015–March 2016.

The author later used time outside working hours with contribution from others including one of the research directors at EIT and the builder of the original log cabin (hereafter called B1) to complete the construction of the greenhouse (Figure 6.13). The window sashes used for the exterior of the greenhouse were sourced from a building recycler and the exterior door was relocated from the bathroom. Sponsorship from ITM paid for materials, with help from a grant of \$4,000 through the EIT Research Fund.

6.8.4 Building the interior walls

Interior alterations included an additional internal timber frame to the external log walls and a timber frame bathroom wall. B1 and two technicians from the VAD programme helped the author with the wall construction and lining. A family friend also offered to help after visiting the project. Recycled timber was used in the framing along with a reused interior door. The electrical installations were put in by a group of Trades students.

Figure 6.14 Kitchen bench refitted (Top Left), damaged door fixed (Top Right), and glass fixing (Bottom Left and Right).

6.8.5 Refitting other building components

Works included retrofitting and restoring the damaged kitchen bench, reinstalling window glass, and fixing a damaged interior door caused by vandalism (see section 6.7). A professional joiner extended and modified the existing kitchen sink

to hide the dent in the kitchen bench at a discounted price. Project sponsor Nicolglass® agreed to reinstall all window glass, some with double glazing, at half price, while a VAD technician offered to fix the damaged interior door without being asked (Figure 6.14) (Bahho et al., 2016). The new bathroom was fitted with a recycled stainless steel shower and galvanized steel linings surplus to the requirement of the VAD programme. A VAD technician volunteered to make the bathroom vanity bench.

6.8.6 Plumbing works

Plumbing was a costly item in the LC refurbishment, as Trades could not help because of timing with their curriculum and the fact the LC building had to be ready for visitors by a certain time. Consequently, it was decided to finish the interior lining, leaving the lower row of plywood sheets temporarily screwed to the frames, to be fixed permanently after the plumbing work is completed. Bathroom and other fixtures were also ‘put in place’ without connections. Recently, the programme coordinator of the Trades Programme offered to help execute the plumbing works by including the works as part of their curriculum in 2017. This will include installing the solar hot water system. It is worth noting that EMS, sponsors of the wastewater and sewage treatment system, are still on board but cannot do their part until the plumbing is ready.

6.9 Other related actions

6.9.1 Project graphic design

In September 2015 a group of 25 students at VAD were offered the opportunity to generate graphic design and branding concepts for the exhibition and promotion material for the LCP as part of their Second Year Design Studio Project. Seven students chose to take part, forming another group for the investigation of values and attitudes. Details of this student group are set out in Table 6.1. The branding brief entailed defining the distinctive features of the LCP and associated stories that could be contextualised in unique and simulating ways. These included a brand name, identity, colour, billboard design, promotion material design, exhibition layout, and ways of displaying samples.

The author set the guidelines for the brief, and also acted as the ‘client’ supplying the necessary information for the students. The aim of the brief was to explore the manner by which information could be planned and exhibited to communicate sustainable concepts and practices clearly and usefully.

The studio format and content were similar to that adopted in the concept design brief (Section 6.2.3). Figure 6.15 shows samples of the students’ work. The students were motivated and went beyond what was required in the brief.

Figure 6.15 Way-finding design (Top Left), project billboard (Top Right), and both sides of the project brochure (Bottom Left and Right).

A pre-engagement focus group interview was conducted with the seven students, along with the questionnaire given to the whole VAD group. This was similar to the project concept designers (Section 6.5.4). The results of thematic and quantitative analyses are in Chapter 7. To look at the influence of the project on

environmental values, both surveys were repeated six months after the end of the graphic design work.

6.9.2 The LCP documentary

A documentary motion picture about the LCP was offered as an option to Second Year students in the Screen Production programme at EIT. This is part of the curriculum where a student has to produce a movie based on an event. One student took up the option and the reason for so doing was probed in a pre and post engagement interview. The student and the crew of three fellow students created a documentary about the history of the LC and its future prospects, interviewing B1 for the former and the author for the latter. The student presented a copy of the documentary for screening to the LC visitors.

6.9.3 Sustainable landscape

As the LC progressed a number of staff at EIT were inspired to become involved including the coordinator of the Horticulture Programme. With a team of staff and students a plan was developed to transform the area around the LC to become a bird and insect sanctuary through the design of a sustainable landscape and the growing of native plants (Figure 6.16).

Figure 6.16 Student planting outside the LC.

Another lecturer in the Nursing Programme proposed using a patch set aside to grow medicinal plants in order to observe Māori Rongoā Pharmacology. A third staff member wanted a patch to grow Pacific medicinal plants.

6.9.4 How is the LC going to be utilised

In discussion with a range of EIT staff and management on how to use the building when it is finished, a proposal suggested that the building could be used in the ways described below.

A demonstration facility for sustainability: The main objective of the building project is to operate as a *good example* for sustainable practices for the public. The idea that groups from schools and the community are able visit, learn, and participate in workshops run at the LC, so it becomes the heart of community environmental education (Section 3.3). Workshops relating to sustainability topics such as organic food growing, composting, and recycling, as well as sustainable building related practices, and environmental processes are envisaged. The Environment Centre in Hawke's Bay has expressed strong interest in running part of their workshop programme using the building and its immediate surroundings. An average of two days a week of community engagement is expected.

A teaching facility: There is potential for using the building as a teaching facility to deliver components of particular EIT programmes environmentally or sustainability related. The author pursued an expression of interest from a number of such programmes. Nine have indicated interest and contributed ideas on ways the facility could be used for teaching. A total of 67 teaching hours per year, an average of 1 hour/day for 2 days/week, is expected.

6.9.5 Volunteers for the project works

As mentioned before, there were contributions to the project works from a number of volunteer supporters from EIT and the community. It seemed that when the building was almost half finished people began to offer to be involved *without being asked*. In addition to the previously mentioned two VAD technicians, B1, the research director at EIT, management (head of ideaschool®), the programme coordinator of the Trades, and the programme coordinator of Horticulture, there were offers from a VAD tutor to help with the curtains

(September 2016), three personal friends of the author separately offered to help with painting and building works after visiting the project (December 2015, January 2016, and September 2016), and four VAD students helped (July 2015, November 2015, February 2016, and March 2016). Additionally, inspired by the LCP, five design students volunteered to help respond to inquiries from the Environment Centre HB website.

6.10 LC visits

The research objective is to investigate the effects visiting a demonstration sustainable building might have on people's attitudes towards sustainability issues, and whether the methods of making the LC more sustainable influenced how people think about their own living environments. The surveys undertaken are explained in Section 7.6.2 and the results given in Section 7.6.7.

Prior to the LCP visit, and with written consent, participants were asked to fill in the pre-visit questionnaire. Subsequently, they were taken in a group or individually on LC tours where sustainable building practices, techniques, and environmental methods were explained. After, a post-visit survey was conducted. The visitor groups were VAD students, EIT students, EIT staff, Environmental Centre Hawke's Bay, and EIT Trades students⁵.

6.11 Summary

Chapter 6 discussed how the LC project was set up and the process of establishing a framework for retrofitting the building to become a demonstration project for sustainable construction and a facility to inspire responsible environmental behaviour. There has been little architectural research into the effect of demonstration retrofitted sustainable buildings on educating people about what is possible. The process for developing sustainable design criteria for the LC was

⁵ Group visits to the LCP continued after the visitor surveys were written up. Appendix 13 contains a copy of the latest letter following a visit of 24 international government officials from six countries in South East Asia, currently enrolled in the EIT English Language Training for Officials (ELTO) programme.

discussed, given the wide body of knowledge about what a sustainable building might be. The chapter described the involvement of two groups of students at EIT. How the first group went about creating a brief and concept design for the building is described, together with how the second group generated the graphic design and branding concepts for the project graphic design and branding concepts.

The chapter also discussed ways of raising funds through sponsorship to support the project and in order to explore the motivation of the individuals and groups who choose to become involved. It explained the engagement of groups from tertiary education and the building industry in the refurbishment of the building. The ultimate aim is to analyse why participants become involved in the project, and if their engagement had an effect on their attitudes and values towards sustainability

Finally, for visitors to the LC, design for behaviour change is an opportunity whereby a sustainable building displays environmental practices and solutions as good examples that could be adopted in their own homes.

Chapter 7: Analysis and Results

“There are lies, damned lies and statistics.”

Probably wrongly attributed to Benjamin Disraeli, 1895.

(<https://www.york.ac.uk/depts/maths/histstat/lies.htm>.)

This chapter presents the results of the investigation of the actors associated with the project at the three stages of design, building, and demonstration. A series of pre and post-engagement interviews and focus group discussions were conducted in order to understand why individuals became engaged in the project and their attitudes towards behaving sustainably. These were paralleled by a survey of values and attitudes. The same surveys were given to students who turned down the chance to be involved in the project’s design and graphic design. Later, visitors’ surveys were undertaken pre and post visit to find whether being in contact with the project was a catalyst for inspiring pro-environmental actions. Ethics approval for administering focus groups, interviews, and surveys was granted by the Ethics Committee of Victoria University of Wellington (Appendix 1).

Table 7.1 outlines the actors investigated and the type of investigation performed. It is important to note that both ‘student builders’ and ‘student electricians’ were excluded from the post engagement focus group analysis as both groups of students finished studying at EIT shortly after their participation. Additionally, both ‘volunteers’ and ‘management’ were only investigated following their offer to support the project works while the building was underway, hence the investigations were only related to their particular contribution or level of engagement.

Actors	No of participants	Pre engagement	Post engagement	Type of investigation	Type of analysis
Student designers	6	Yes	Yes	Focus group Survey	Thematic Quantitative
Sponsors	2	Yes	Yes	Interview	Thematic
Student graphic designers	7	Yes	Yes	Focus group Survey	Thematic Quantitative
Student builders	12	Yes	No ⁽¹⁾	Focus group	–
Student electricians	11	Yes	No ⁽¹⁾	Focus group	–
Volunteers	5	No ⁽²⁾	Yes	Interview	Thematic
Management	2	No ⁽²⁾	Yes	Interview	Thematic
Visitors	194	Yes	Yes	Survey	Quantitative

Table 7.1 Actors investigated

⁽¹⁾ Post engagement could not be organized as students left EIT. ⁽²⁾ Actors investigated after offering support to the LCP

This chapter presents detailed qualitative analysis related to the ‘student designers’ and ‘student graphic designers’ groups, as well as the quantitative analysis of the ‘visitors’ group. Highlights of interviews with ‘sponsors’, ‘volunteers’ and ‘management’ are also presented. Comparisons between groups of actors are in chapter 8.

7.1 Student designers

Two focus groups were conducted with the student designers, pre and post-engagement. In addition, a pre-engagement survey was given to the whole design student group to compare LCP students with those who chose other design course options (Appendix 5).

7.1.1 Pre-engagement focus group analysis

The aim of the first focus group discussion was to establish a benchmark of the participants' understandings of and concerns for environmental issues before engaging in the project.

7.1.1.1 Participants and procedure

A focus group was conducted with the six student designers (identified as SD1 – SD6) prior to their involvement with the design stage of the project. The discussions explored responses to a two-part question: *How concerned are you about the harm that humans are causing to the environment? Looking ahead to the year 2050, are you concerned about the consequences of environmental problems in relation to each of the following clusters: the biosphere, yourself, and other people.* The second question was based on Schultz's (2001) three clusters of environmental attitudes related to environmental concerns. These are egoistic (me, my health, my lifestyle, and my future), altruistic (all people, children, my children, and people in New Zealand), and biospheric (plants, marine life, animals, and birds). This type of question has been used before in New Zealand, so the results can be compared with other studies (Milfont, 2007, p. 32–34). The focus group session took place in a lecture room at the EIT campus. An hour was set aside for discussion, but the session lasted 37 minutes. The author was the only non-participant present and the discussion was recorded. The student participants contributed to the discussion in varying degrees.

7.1.1.2 Data analysis

As stated in Section 5.4.3, analysis of the data to identify recurrent themes was based on the *thematic analysis* guidelines (Braun & Clarke, 2006). The recorded data was first transcribed. Quotes were then extracted and each referenced to the time the comment was made at the focus group. All quotes in the discussion below were extracted verbatim from the transcripts.

After becoming familiarised with the data, an initial list of codes was generated from the various topics brought up by the students (Braun & Clarke, 2006)

(Appendix 8). This was done across the data set, rather than for each question individually in order to identify commonalities running through the data. Working from the perspective of environmental attitudes, the aim was to find out why individuals chose to be involved in the project as part of their education at EIT. To achieve this, repeated rounds of reading and categorising the data led to the emergence of broad themes, and specific sub-themes within these, all derived from the data (Braun & Clarke, 2006; Boyatzis, 1998, pp.44–48). An *initial* thematic map was prepared (Figure 7.1). The themes identified were “the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon” (Boyatzis, 1998, p.63). These were then reviewed and refined through repeated investigation both of pattern and commonality to create a *developed* thematic map (Figure 7.2) (Braun & Clarke, 2006). Direct quotes from the transcripts were grouped under similar thematic headings to provide a clear illustration of each theme in the participants’ own words, and to give an indication of the number of participants who addressed each theme (or sub-theme). From this a *final* thematic map emerged (Figure 7.3). While frequency is not necessarily a measure of significance, it offers a sense of the extent to which a particular experience was common across responses, and so the extent to which it might represent a shared understanding, or agreement with others.

Figure 7.1 Initial thematic map: pre-engagement focus group analysis of concept design students.

Figure 7.2 Developed thematic map: pre-engagement focus group analysis of concept design students.

Figure 7.3 Final thematic map: pre-engagement focus group analysis of concept design students.

7.1.1.3 Results

Consequent to review and refinement, three main themes emerged:

- (1) Support for responsible environmental behaviour,
- (2) The need to be environmentally motivated, and
- (3) Concerns about the future as result of human activities

Below these three main themes are discussed individually, along with the specific sub-themes within them.

(1) *Support for responsible environmental behaviour.*

The students stressed the importance of living sustainably with an emphasis on health, valuing sustainable living patterns, and being in an ecological and organic living environment. There was a notable call for nurturing responsible environmental attitudes in the community through inspiring the behaviour of others, supporting environmental actions, and being passionate about animals and ecosystems. Concerns for environmental behaviour ranged from concerns for self (health and nutrition) to taking a wider view that could still incorporate self (concern for organic living environment). Accordingly, from each of these points the following sub-themes were obtained:

- *Living sustainably.* The students displayed environmentally responsible views in realising the importance of living sustainably focusing first on a nutritious diet and rejecting processed food as being “unhealthy” and “terrible stuff”. SD6 commented, “the unhealthy stuff is quite addictive, there is no what I call real food” then went on to stress “I very rarely buy packet food” (23:30). That student considered it particularly important that people read the content of food items, observing “when you go next time to the supermarket, take time to look at other people’s trolleys. Don’t they read what’s on the label?” (22:50). With regard to dealing with health matters and medication, most students (four participants) were cautious of pharmaceutical drugs preferring natural (or no) remedies. SD4 stated, “If I have a headache I refuse to take Panadol until I am in excruciating pain because I want my body to deal with it” (14:40).

During the discussion, four participants seemed to value sustainable living and felt passionate about ecological living practices. Planning to build a new home, SD6 revealed a responsible environmental attitude by wanting to create a living environment that “will have a sustainable life style like an autonomous place” (8:38), while SD2, feeling the effects of rising petrol prices on fellow students considered carpooling stating, “I want to take a car pool with me, but I can’t because of afternoon commitments” (12:44), to which SD1 suggested, “you can be creative and, you know, try to do things differently” (13:30). SD2 made the decision to take fellow students to EIT as an environmental action explaining “there was something on the radio about petrol prices...I shouldn’t be driving to school by myself” (12:44), thus demonstrating motivation to be environmentally responsible. In this case, the last three students demonstrated awareness and desire to act responsibly and ecologically. However, SD5 who drives to school daily seemed unconcerned about the issue of petrol prices “It doesn’t worry me but I can’t do anything about it. I try” (12:28).

Participants were aware of the physical and environmental qualities that New Zealand possesses, expressing appreciation for the general respect for ecology and nature. SD2 commented, “A lot of people don’t really realise how lucky they are in New Zealand, we have fresh water, and we don’t really have pollution. We have a big ozone layer! But we don’t wear a mask or drink water from the bottle” (5:58). Two participants (SD1 and SD2) highlighted the importance of environmental education at home. Learning from parents, SD2 described how to try to find natural and organic alternatives for nutrition and health stating, “we always had a vegetable garden, always grown things organic, and my mum always, instead of taking you to the doctor and put you on antibiotics, finds what else we can do” (14:08). SD1 stressed the significance of environmental education at home explaining, “my little girl...is talking to another nine year old and she is quite aware of what she eats and what is not good for her...as she is used to hearing them” (20:22).

- *Nurturing responsible environmental attitudes in the community.* Students' concerns about environmental issues and the need to nurture responsible environmental attitudes ranged from local issues to taking a wider, global view that still incorporated the community. However, some felt influencing future directions towards sustainability was too big a step. SD3 felt too young and still learning, but would consider motivating others when being in a job "and may be able to do things within that job that can affect that sort of thing" (18:42). However, SD1 urged that student to be active in affecting other peoples' attitudes at present affirming, "because when you talk to other people, you are...making them more aware so that you can actually do something now, even if it is only small" (19:16).

In terms of taking a wider, global view, the students believed that the future of the planet and sustainable development are both unknown but they differed in their approach to these issues. SD1 felt the need to educate the wider community "if we want to have a world left, it is going to be sustainable or we won't be here in 2050, we won't have water. We won't be able to live" (11:10). Others were more skeptical of the ability to influence people, as SD2 commented, "How do you educate people in the world though? How do you make countries, that don't want to have a bar of it, be aware?" (11:44).

- *Supporting environmental actions.* All six participants were generally concerned about the harm human actions have caused to animals, plants, and marine life, valuing the need to protect natural entities and to support conservation efforts. SD6 stated "anything extinct is going to impact on us globally" (2:52), while SD1 was critical of the local lack of action in addressing environmental problems, referring to reports of waste found in rivers in the central North Island of New Zealand, stating "things come up with the water and they just don't know what to do, so they do nothing,

which is quite just as bad” (6:38), and further claiming “we are not as green as we think we are” (6:38).

With regard to health, SD2 and SD6 emphasised the importance of a healthy, natural diet on human well-being. Commenting on the family, SD6 stated, “we always want to fix health problems with diet rather than medication” (8:55). SD2 declared resorting to medication only when the natural “is not working, and it is like I have to think of other things.” (15:10).

(2) *The need to be environmentally motivated.*

The students highlighted the importance of environmental motivation through discussion and practice at the various levels of self, family, and community. There was also emphasis on the need to acquire in-depth environmental knowledge. They saw involvement with the LCP as an opportunity to focus beyond basic ecological knowledge and issue awareness (Hungerford & Volk, 1990). Communicating information, including the role of the media, was also stressed. Accordingly, for each of these points, the following emerged.

- *Motivating self and others.* Student participants were generally self-motivated to carry out sustainable actions, which explained their willingness to be involved in the LCP concept design. SD4 clarified the reasons for involvement as “because I am inspired by that sort of stuff” (10:17). Moreover, involvement demonstrated the students’ passion for influencing others and the public to behave sustainably. SD1 urged a fellow student to speak to others about good sustainable practices “because when you talk to other people, you are informing them and making them more aware” (19:16), SD6 stated, “and you will be automatically teaching it to your children too!” (19:33), demonstrating strong will to motivate younger generations.
- *Acquiring in-depth environmental knowledge.* Thorough understanding of environmental issues should enable individuals to comprehend nature

and understand ecological and human implications before engaging in environmental actions (Hungerford & Volk, 1990). In discussing the effects of human actions on marine life, SD2 wanted to find out more about endangered marine species declaring, “nobody here will be able to tell you that these species are going to be extinct” (3:30), while SD1 replied “there are people now who are keeping an eye on that and they will tell us for example, stop fishing in this certain area and so on” (3:55) implying that the relevant information is there, but we need to know where to look for it.

Three students were concerned about harmful chemical substances in certain body care products. SD1 pointed out the existence of hazardous chemicals in some hair and nail products, which could potentially harm human health stating, “I don’t think people are aware of what is in them” (24:36). SD4 made a similar point about make-up stressing, “and also there is the make-up stuff that is tested on animals...people don’t know enough about it” (24:51), while SD6 commented on the lack of awareness about the consequences of buying such products affirming “but do they care? Do they know what they are actually buying?” (25:00).

- *Communicating information.* Two students believed communicating correct information to others is crucial in the training of responsible citizens, since this gives people the sense they can make changes and assists in resolving important environmental issues (Bamberg & Moser, 2007). In this respect, SD2 acknowledged the influence of parenting on eating healthily “I guess I have been lucky with my parents, one is a gardener and the other is a chef...I’ve always grown up conscious about my health” (14:08). SD2 also compared the upbringing of two children in the family stating, ‘K feeds his boy all organic and healthy and really well educated...but A’s sister is lazy and feeds the children junk food and you can see the difference in metabolism and activities and energy” (20:52). SD1 believed that for humanity to survive the public need to be informed, “there is no choice!”

(11:10). SD2 agreed, recognising that environmental problems are global and being educated about environmental problems is vital, but was uncertain about what to do, “How do you tell these ones and change them?” (11:44). Participants sensed that projects such as the LC have the potential to educate the community about living sustainably.

(3) Concerns about the future as a result of human activities.

All participants shared a sense of concern and a degree of pessimism when it came to envisioning the future of the world, due to general concerns about rapid population expansion and increasing demand for materials placing stress on space and resources. Students felt this could result in adverse consequences and environmental problems for the future of the planet and its ecosystems. The importance of preserving natural capital for current and future generations was also emphasised. Furthermore, the contemporary consumerist culture of obtaining more and more material possessions was perceived as putting extra pressure on resources and causing an increase in the gap between rich and poor. The following sub-themes emerged in relation to these points.

- *Concerns about the future of the planet and its ecosystems.* Three participants were concerned and rather pessimistic about the future of humanity. SD4 believed the right direction for a better future to be one of change towards sustainability, “but I don’t think it is going to happen”, because the nature of such change “is slow and it does not seem as important as it actually is” (31:06). Referring to predicted adverse consequences, SD4 also commented on the urgency of change explaining, “because it is not happening right now, people wouldn’t think it is as this huge thing” (31:10). SD1 believed life would “become quite segregated” as “people will be of different classes.” She drew a distinction between people that “will live off the land, but they will be quite isolated” and others living in “cities that will be overpopulated and dirty” (29:29), drawing a picture of chaos and selfishness as a result of competition for resources SD6 was extreme in concerns about “what happens when the world population explodes?” not ruling out the possibility of powerful countries using

military force to invade smaller countries with rich reserves stating “they will run out of resources...and New Zealand is going to be a prime target” (27:34).

The same three participants believed that people and governments should support the idea of investing in green development by adopting environmental action strategies.

- *Preserving natural capital for current and future generations.* Three participants were clear that protecting land, air, water, sea, and ecosystems is critically important for the future of the planet. SD2 was concerned about threats to natural habitat and particularly rainforest because of the biodiversity they contain warning, “there will be no more rainforests...they will be smaller” (30:14). SD1 was worried about landfill and contamination of the oceans stating, “all the waste and, you know, computers’ waste will contaminate our oceans” (30:29). SD3 thought that growth in population in other parts of the world meant a country such as New Zealand “will be thriving!” (27:28), because of the relatively small population compared to the available land and other resources. SD2 saw the potential of producing bio-fuel proposing, “we could be such a massive dairy farming region, why couldn’t someone create a car that could run off methane or biogas” (32:43), suggesting utilising local and available resources to produce the fuel needed to run vehicles.
- *The spread of consumerist attitudes.* Three participants commented on contemporary business and economic practices. SD4 alluded to the current social and marketing ideologies encouraging the acquisition of goods and services in increasing amounts stressing, “people seem kind of money hungry, not all of them, they want to make things that can be addictive, like they make all these apps and things to get people just to buy” (34:06). SD4 also pointed to the promotional marketing strategies for launching new products giving an example of “the newest iPhone...gets so much hype and everyone will say let’s get rid of our old

phones, throw them away” (32:20). SD1 commented on the conflict between business and sustainability, “Do you know how they designed cars in the past that run off no oil, but then they were paid out because they don’t want the oil companies to go out of business” (31:54). SD5 talked about having the vision to see into the future in terms of the ecology of the planet “maybe people will start realising when it is too late and think about it” (33:52).

7.1.1.4 Conclusions

For a qualitative analysis the group of six participants is small, however the level and type of information extracted was focused, rich, and diverse. The open-ended questions allowed participants to communicate their own experiences in their own words. As such, the themes identified reflected the spontaneous use of common terms and offered powerful evidence of shared ideas of what it means to be sustainable in New Zealand today. Moreover, observations of commonly experienced reactions to unsustainable practices suggested the participants’ strong passion, motivation, and intention to be sustainable, and for some to try to influence others to behave sustainably and be ecologically responsible. It also offered an insight into why this group of individuals became involved in the project. Reactions to the two-part question showed the need for in-depth knowledge about sustainable topics and practices so the students could feel confident in taking ownership of environmental issues and later using this knowledge to empower others into holding sustainable values and having knowledge of environmental action strategies. The analysis offered qualitative evidence for basic understanding of self, others, and the biosphere in relation to social, environmental, and economic platforms, and that the students had the knowledge and intention to act sustainably. Further, it added to the claim that green practices are also political, rather than just being issues of personal interest.

7.1.2 Pre-engagement student survey

The whole design student cohort completed a written survey. The aim of the survey was to gather information on the level of understanding and concern

about environmental issues and their effects on communities, and further to explore the motivation of individuals who chose to become involved in the project (see Section 7.6.2). The survey was a three-part questionnaire, with all questions scaled from 1 strongly disagree to 7 strongly agree. The first section was based on the 12 items of Environmental Concerns (ECs) motives from Schultz (2001) (Section 3.2.1), the second was related to all 13 items of Adverse Consequences (ACs) beliefs published in Snelgar (2006) (Section 3.2.2), while the third utilised the 15 items of the NEP from Dunlap et al. (2000) (Section 3.2.3). A score for each item was calculated including mean and standard deviation values. The scores were compared with similar validated research. Results are in Section 8.1.1 and Tables 8.2 and 8.3.

7.1.3 Post-engagement focus group analysis

A post-engagement focus group discussion was conducted with the same group to compare data and look for any effects that might be linked to having been involved in the LCP concept design.

7.1.3.1 Participants and procedure

This focus group was conducted with five of the participant students (SD1 – SD5) nine months after their involvement with the LCP concept design. Having moved to another town SD6 was not available although a similar interview was arranged at a later date. The thematic analysis uses data from both the focus group and the interview. Both sessions aimed to explore responses to the same questions posed in the first focus group: *How concerned are you about the harm that humans are causing to the environment? Looking ahead to the year 2050, are you concerned about the environmental problems in relation to each of the following valued object groups: the biosphere, yourself, and other people.* In this post involvement discussion, an additional question was asked: *Did the experience of being involved in the design of the LC project affect the way you acted recently in relation to sustainability?*

The focus group with the five student designers took place in a meeting room at the EIT campus, while the meeting with SD6 was in the library. An hour was allocated for both and the discussions went for 41 minutes (0:00 – 41:00) and

17minutes (42:00 – 58:00) respectively. The author was the only person present in both and both discussions were recorded.

7.1.3.2 Data analysis

Thematic analysis was also used to identify recurrent themes in the data (Braun & Clarke, 2006). The process adopted was similar to that explained in Section 7.1.1.2. Generally, at the post-engagement phase potential changes as reported by the participants were examined by evaluating data from the focus group discussions on a person by person basis. This happened for both the student designer and student graphic designer groups (see Section 7.3.3.4).

7.1.3.3 Results

Upon arriving at a satisfactory thematic map of the data, the dominant themes were organised (Braun & Clarke, 2006, pp. 22, 23). This produced three main themes, which are discussed below.

- (1) Willingness to enable environmental practices;
- (2) Having the motivation to support environmental actions; and
- (3) Seeking in-depth and ongoing knowledge of environmental issues.

(1) Willingness to enable environmental practices.

The students stressed the importance of using energy and other natural resources responsibly, and were motivated to choose sustainable options in spite of cost, at least at times. The participants were also keen to acquire in-depth knowledge of the effects of environmentally harmful food growing processing practices. Accordingly, the following sub-themes emerged.

- The students displayed environmentally responsible views in terms of energy awareness and the use of resources during their involvement in the concept design stage of the LC project. In addition, through investigations and discussions, they favoured ideas that had the potential to achieve energy and material savings, particularly savings in natural resources, such as deciding to generate the electricity needed from renewable sources and choosing to preserve and refit the existing LC stairs, kitchen, and doors. In the project investigations, the student designers also

considered using recycled materials as well as keeping the existing components if possible. This responsible attitude has led to SD6 establishing a business around reusing and repurposing objects of desire, “I am doing a lot of things with textiles and also furniture, anything that I can find to turn into something else” (53:50).

- On the cost of making things sustainable, SD1 justified the extra for natural products “to make all natural stuff is probably more expensive because they don’t make it out of cheap bulk petrochemicals” (18:18). SD1 went on to state, “you may need to use a little bit less” (18:30) in order to stretch the use of this type of product. This same student was prepared to pay for products that use organic ingredients because they are beneficial for health and cause no harm to the body. SD2 and SD3 showed awareness of the importance of opting for the sustainable choice even if this is sometimes more costly.
- The student designers also emphasised the significance of acquiring environmental knowledge, particularly knowledge about food, its contents, and healthy eating habits. Of particular concern to the group was the use of chemicals in growing crops, as well as additives in processed food, “poison and pesticides are huge to me, it is worldwide and people are protesting and that affects every single one of nature, animals, and us” as SD1 explained (9:36). Consequently, the students carried out environmental actions, for example SD2 persuaded a couple of flat mates to check the contents of food products to ensure healthy standards were followed during shopping explaining, “I’ve been trying to educate my flat mates because they don’t cook and I’ve been trying to show them how to shop. When I shop I look at the labels” (13:03).

(2) Having the motivation to support environmental actions

Post involvement in the LC project, a number of students tried to convince those close to them to act in an environmentally responsive way. They showed

willingness to support others make environmentally sound decisions and assist them to change their environmental behaviour, thus demonstrating ownership and empowerment qualities (Hungerford & Volk, 1990). As evidence of this, students highlighted the importance of supporting and educating others to act sustainably, being self-motivated in pursuing environmental initiatives, and encouraging others to adopt sustainable practices.

- The students realised the significance of educating others about environmental issues and how to act responsibly, starting with family members and others close to them. On the topic of a healthy and organic diet, SD1 reported, “I really talk to my daughter about that all the time, I explain to her what are GMOs [Genetically Modified Organisms]” (9:55), while SD5 commented, “at my work, they are trying to be sustainable and they are recycling and reusing, but there is still a lot of waste!” (5:58). SD6 described the transformation in the family’s diet, “our own lifestyle has changed completely in a lot of ways, and even in the way we eat...no processed food anymore” (47:02). SD1 offered to help friends establish a social media network page to exchange information on environmental and health matters of interest, demonstrating ascription of responsibility beliefs (Stern et al., 1999) stating, “I treat my Facebook as a kind of news page...it gives you a kind of news you can read, and it is like me reading a newspaper because I can read stuff that I am interested in” (15:14).
- Self-motivation to pursue environmental initiatives was evident in the participants’ actions. A number were passionate about re-purposing and re-using discarded household items. As SD6 described, “my design direction and thoughts that I want to go ahead with are definitely in that space re-purposing and re-claiming things, taking something that has been discarded and turn it into something beautiful” (53:14). SD6 is developing this idea as a business. SD2 considered it particularly important to find ways to reuse materials, explaining, “I am doing a few things like lighting and so I am trying to reuse and recycle objects into

creating a light instead of getting a manufacturer to use materials that are machined” (30:56). Referring to the methods adopted in the design of the LCP, SD2 stressed, “I don’t think if I haven’t done the project I would consider using these” (32:10). SD4 believed in an ecological way of life in the future “because we may come up with alternatives” (22:41). SD5 had designed a café for a final year project where produce grown on site was used in the menu. SD5 was very quiet in the first focus group, but was now confidently explaining, “I became aware of several things like growing own vegetables, that kind of thing made me develop concepts for my project” (30:31).

- Some participants were successful in encouraging other people to act in an environmentally responsive way. Discussions revealed instances where participants demonstrated active pro-environmental behaviour, such as SD6 convincing a close friend to invest in photovoltaic technology in order to minimize the electricity bill in the face of reduced income, stressing “when he starts spending more time at home after retirement, his power bill is going to go up, which he should consider” (48:27). This demonstrated strong pro-environmental intentions and awareness of adverse consequences (Joireman et al., 2001).

(3) Seeking in-depth and ongoing knowledge of environmental issues

The students asserted the significance of continuously pursuing knowledge about matters related to ecology and the environment. This included the ability to define the characteristics of a sustainable practice, the ability to recognize the need to extend personal knowledge of environmental issues, and the hope their knowledge could be applied in new and emerging job opportunities related to sustainability. They highlighted the significance of conservationist living patterns.

- The students described sustainable practice as one that is *well considered* in terms of its thorough respect and understanding of all the elements and resources put into an operation that can potentially affect the environment. SD1 student explained, “All elements got to be well

considered with regard to the environment, materials, how it is going to be used, the resources available, etc.” (00:41). SD2 stressed the importance of recognising the *small steps* emphasising the issue of relative contribution to sustainable practice,

“You’ve got a family that lives in a home and they try to change their ways even though they might be doing small things, that is considered sustainable because they are trying, but you’ve got larger companies who have got the money and are able to change things dramatically or build something and that is sustainable as well. So the scale is different” (1:30).

- There was general interest in continuing the search for information about environmental topics, in particular organic and healthy ways of living and eating, as well as knowledge of passive methods of building. As SD4 put it, “I don’t think we will ever get to a stage where we can stop improving” (7:17). Both SD1 and SD2 were particularly keen on being constantly informed about the effects of using chemicals on crops, whether as a means for disease control or to improve yield production. This had led to investigating the biological effects of Genetically Modified Organisms (GMOs) in New Zealand and both were keen to educate the community on that matter. SD3 then became interested in the subject, “I think that information needs to be more accessible” (15:45). SD2 was self-motivated in environmental action by encouraging colleagues to form a network to exchange information about matters related to sustainability that are of common interest, “you can do that as a group in school so that people will click on the link and that takes you to the actual site” (16:11). That student demonstrated knowledge of and skills in using environmental action strategies (Hungerford & Volk, 1990).
- On the subject of applying environmental knowledge to new job opportunities, the students in general had faith in developing more environmentally responsible products and hence the emergence of jobs

related to sustainability, conservation, and ecology. They were not concerned that protecting the environment would threaten their future jobs, on the contrary, they showed real belief in the future of the planet, as SD2 put it, “yeh it will be new products and new jobs without all the harsh chemicals” (22:53). Another student sees a future job in self-employment, working from a small workshop at home. The business is about recycling, refitting, and repurposing discarded household items as desirable items. SD6 is aware of the need to minimise the use of natural resources as a way of being environmentally responsible stating, “I think that is the way for the future, and people need to start considering that, because we are draining our natural resources” (42:05).

7.1.3.4 Conclusions

Interviews with the students who chose to be involved in designing the LC project highlighted the significance of living sustainably, valuing ecological and organic living practices, stressing the importance of using energy and other natural resources responsibly, and being motivated to choose sustainable options in spite of cost, at least at times. The participants were keen to acquire in-depth knowledge about environmental matters, particularly focusing on the effects of non-environmentally harmful food growing and processing practices.

Subsequent to their involvement in designing the LC, the student designers’ passion for supporting and educating others to act sustainably was observed. They were self-motivated to pursue environmental initiatives, and realised the significance of encouraging others to make environmental investments. The discussion revealed a number of instances where participant students demonstrated active pro-environmental behaviour, such as convincing a close friend to invest in purchasing photovoltaic technology for a lower electricity bill in the face of reduced income and more time at home after retirement. This demonstrated strong pro-environmental intentions and awareness of adverse consequences (Joireman et al., 2001). Another student concerned about health and nutrition, encouraged flat mates to start looking at the ingredients as a guide

to food product choices, showing social altruistic concerns (Schultz et al, 2001). A third student offered to help friends establish a social media network page to exchange information on environmental and health interests, demonstrating ascription of responsibility beliefs (Stern et al., 1999).

7.2 Sponsor interview analysis

A similar process was used with the sponsors in terms of pre and post-engagement investigation, though in this case interviews were used rather than a focus group. This section focuses on interviews conducted with two sponsors (Independent Timber Merchants (ITM), suppliers of the building materials for the project; and Gemco Group Holdings (GGH), identified as SP1 and SP2). Once information from the initial pre engagement interviews was analysed, both sponsors were invited to a separate post-engagement interview.

7.2.1 Pre-engagement interview analysis

The aim of the interviews was to find out the motivations behind each of the two sponsors' support for the LCP.

7.2.1.1 Participants and procedure

The separate interviews focused on three themes. These were general awareness of environmental issues, engagement in this demonstration project, and the company and sustainable practice (Appendix 9). Within these themes, interviews aimed to explore the response to the following three questions: *What do you consider a sustainable building to be? Why did you decide to support this project? And is sustainable development a field where your company can contribute?*

Both interviews took place in April 2013. Although planned for 60 minutes, the interviews took 43 minutes and 33 minutes respectively. The first with ITM took place at their office, while the second with GGH was held at the author's office at EIT. Both interviews were recorded and the records transcribed.

7.2.1.2 Data analysis

Thematic analysis techniques were also used to examine and clarify the reasons for involvement in the project (Braun & Clarke, 2006, pp.18–21). The process adopted was similar to that explained in Section 7.1.1.

7.2.1.3 Results

Transcripts of the interviews were used as a basis for the analysis, and three themes emerged.

- (1) Seeking to progress knowledge of environmental practices;
- (2) Promoting the advancement of sustainable materials and techniques;
and
- (3) Exploring the relationship between sustainable choices and affordability.

Each theme was directly linked to the three questions. The following gives the highlights of the participants' views in relation to each theme.

In relation to the first theme, *seeking to progress knowledge of environmental issues*, both SP1 and SP2 pointed out that people are now more motivated to learn about the characteristics of sustainable materials and technologies, and that business motivation is largely a response to market demands. However, SP1 declared a personal and intrinsic motivation to develop knowledge about and be part of local sustainable building development, pointing to intentions that, along with perceived behavioural control, can influence behaviour (Ajzen, 1991, p.179).

Considering the theme of *promoting the advancement of sustainable materials and techniques*, both sponsors highlighted the need for mandatory adoption of sustainability standards in buildings. They felt the media are not doing enough to promote the sustainability message and observed the public is generally stimulated by the sustainable options. However, SP1 felt there was an element of skepticism in the public view towards a *different method* of building, caused by past experience of leaky buildings (Montgomery, 2009). It is worth mentioning that

ITM maintains strict environmental standards when operating its own sawmills for the supply of timber.

Finally, on the theme of *exploring the relation between sustainable choices and affordability*, both SP1 and SP2 mentioned that affordability is a major factor in the accessibility of sustainable products. SP2 blamed low levels of demand in New Zealand on the relatively high prices of sustainable products. Both sponsors stated some suppliers take advantage of the sustainability slogan to push the sale of particular products. They believed public demand for sustainable materials and technologies as a new market *trend* would be driven by passion for these.

On the question, *which of the actors involved in the building process should drive the sustainable building practice?* both sponsors felt that for residential buildings, designers and home owners would be the main drivers of sustainable building practice, while for commercial buildings, designers were identified as the main drivers, since they write the specifications and hence have a high level of control.

7.2.1.4 Conclusions

For both sponsors opting to support the LCP was based on providing the best approach to achieving benefits for their business. Therefore, the balance of costs and benefits determined the sponsors' preferences and eventually their decision making (David et al., 2013). Besides the desire for both to be involved in sustainable buildings, for ITM supporting the project was part of a business relationship with EIT as they supply building materials for their Trades programme, while GGH are the main contractor for EIT buildings, one of which had a high Green Star rating.

7.2.2 Post-engagement interview analysis

A post engagement interview was conducted independently with each of the two sponsor participants. Each interview aimed to explore the response to the previous three questions, with the added question: *Did the experience of being involved in sponsoring the LC affect the way you do things in your company in relation to sustainability?*

The interview procedure and data analysis method were similar to those adopted at the pre-engagement stage.

7.2.2.1 Results

Transcripts formed the basis for analysis from which three themes were identified.

- (1) Discussion of factors that can prompt environmental actions in various groups;
- (2) Ways of accomplishing more towards sustainability; and
- (3) Motivations for involvement in supporting the LC project.

On the theme of *factors that can prompt environmental actions in various groups*, both SP1 and SP2 felt the public is generally affected by ecological, health, ethical, and environmental considerations, but their actions can be hindered by cost. They also felt designers, an influential group, are driven by environmental values, responsibilities, and what they stand for, while the actions of industry and other corporate bodies are commercially determined. Nevertheless, SP1 thinks corporate bodies want to be seen to be doing something positive for the environment from an image perspective. This sponsor also mentioned that the actions and decisions of material and technology retailers are influenced by a number of factors including industry, markets, and consumer demands.

For the second theme, *ways of accomplishing more towards sustainability*, both sponsors felt public demand for sustainable solutions needed to be generated. SP2 felt the construction industry is prepared to make small proactive moves towards addressing sustainability issues, which will grow with increase in demand. Both sponsors stressed that legislation can speed up the process of applying pro-environmental means to effect change towards sustainability, although SP1 referred to the potential of bureaucratic enhancement, which might work against this. This same sponsor suggested government support of environmental actions

through subsidies would be a valid way, while SP2 called for further utilization of renewable energy sources and less exploitation of natural resources.

The third theme, *motivations for involvement in supporting the LC project*, led the sponsors to state that despite the fact sustainable buildings are not yet mainstream in New Zealand, they are becoming more accepted by the public. Both stressed that the LCP presented an opportunity for accessing in-depth knowledge about sustainable practices, this being their main motivation for involvement. SP2 added, “The idea of school children visiting the project and being exposed to sustainable tools as well as practicing sustainable activities was appealing.” SP1 expressed his company’s aspiration to lead the industry in supporting sustainable practices.

On the question of *has this experience changed the way you do things in your company?* both sponsors alluded to the fact that being at an early stage, it was hard to feel the project’s influence. However, an indirect effect emerged with SP1 noting the recent evolution of a sustainability focus in the market that had coincided with the inception of the LCP. This had created a correlation that helped to make better-informed decisions around the kind of suppliers the company would support.

7.2.2.2 Conclusions

The interviews with the sponsors stressed the *balance* between sustainable solutions and affordability, emphasising the significance of offering the public tangible examples of sustainability they could visit. For the sponsors of building material supplies and labour, affordability is a main concern in the promotion of sustainable materials and techniques, as these are seen as *different* from mainstream products.

The sponsors identified architects and designers as the probable influential actors in the building process for implementing sustainable building. This is because project designers make the decisions about the building, including specification

of materials and techniques to be used. In relation to initiating change towards sustainable building, the sponsors felt industry could make small, proactive moves towards addressing sustainable issues, and these would improve as demand increases. In order to speed the process, both sponsors believed legislation would be the direct way to realise the adoption of sustainable practices and methods in the building sector, yet they were also reluctant to increase bureaucracy in the built environment.

7.3 Student graphic designers

A group of seven graphic design students formed the source of qualitative data. These 7 students opted for the LCP graphic design project out of a pool of 25 students (Section 6.9.1). In addition, pre involvement surveys were given to the whole graphic design student group. Pre and post engagement focus groups were undertaken with those opting to work on the LCP.

7.3.1 Pre-engagement analysis

As mentioned in Section 7.1.1, the aim of the pre-engagement focus group discussions was to establish a benchmark for the participant's knowledge before engagement with the project.

7.3.1.1 Participants and procedure

A focus group was conducted with the seven student participants (identified as SGD1–SGD7) prior to their involvement in the project. They were aged from 20–25 years. The discussions aimed to explore responses to the same two questions posed to the concept design students (Section 7.1.1.1): *How concerned are you about the harm that humans are causing to the environment? Looking ahead to the year 2050, are you concerned about the consequences of environmental problems in relation to each of the following clusters: the biosphere, yourself, and other people.*

The focus group took place in a lecture room at the EIT campus. An hour was set aside for discussion and the session lasted 54 minutes. The author was the only non-participant present and the discussion was recorded.

7.3.1.2 Data analysis

Again thematic analysis techniques were used (Braun & Clarke, 2006). The process was similar to that explained in Section 7.1.1 and Figures 7.1, 7.2, 7.3.

7.3.1.3 Results

Transcripts of the focus group discussion, which identified each student's contribution, were used as a basis for analysis. From the analysis three themes emerged:

- (1) Concerns about the future as a result of human actions;
- (2) The need for environmental awareness, and;
- (3) The need for environmental action (Figure 7.4).

Figure 7.4 Final thematic map from student graphic designer pre-engagement focus group themes.

Below is a discussion of each individual theme, along with its specific sub-themes.

(1) Concerns about the future as a result of human actions

There was notable concern about the effects of environmental problems on human health and welfare, particularly concerning air and water pollution, potential problems due to rise in sea levels, the effects of using chemical agents in

growing crops, and the health effects of the depletion of the ozone layer. Concerns about welfare extended to animals, and ranged from the effects of deforestation on natural animal habitat and the potential negative effects on the climate, the consequences of overfishing on the quality of sea life, and the possible extinction of marine species. The students were worried about the ability to preserve and maintain natural capital for future generations due to deforestation, extensive use of non-renewable energy, and the fast rate of human population growth. They were also concerned about the amount of waste produced, the way it has contributed to the pollution of sea and shore, and the manner in which it has been dealt with.

- *Concern about health and welfare of humans (altruistic) and animals (biospheric).*
Participants were generally concerned about the effects of environmental problems on the health and welfare of humans and animals as a consequence of human activities, especially the pollution of air and water, the environmental effects from climate change, and the use of chemicals such as pesticides in growing crops. On the subject of pollution, SGD1 explained the harm on birds, “there is the issue of pollution, air pollution, it is more affecting birds, it is horrible!” (7:12). SGD4 empathised stating “Pollution that goes into the water affects marine life and into the air affects the birds and us, and everyone” (7:24). The same participant added, “I have concerns about my children swimming in the river and stuff, like we always did as kids” (7:39). In relation to the effects of climate change on the environment, SGD5 was worried about the future state of the planet, “the potential of what we are doing now affects what is going to happen then with rising sea level and all this other s**t that is going on...I think that is scary, that is something that keeps me awake” (9:58). SGD4 was worried about health consequences as a result of the depletion of the ozone layer stressing, “apparently, the ozone layer above New Zealand is quite bad, so I feel we are getting more sun and more skin cancers and things like that happening” (16:03). In relation to the issue of the way animals and plants are grown for human consumption, SGD1 raised concerns about the effects of cruelly treated or hormone overdosed

farm animals on the health of human consumers stating, “How the animals have been treated and the way they have been raised has an effect on our health” (13:44). SGD4 was disturbed by the use of chemicals to increase fruit production affirming, “we used to wipe the apples with our clothes, because the apples get sprayed for whatever reason...do we really need to do these things? Before all these chemicals were invented, we still use these fruit as they seem to come from the earth” (25:08). SGD5 was disturbed by the use of pesticides and other non-natural processes to grow better shaped fruit stating, “I know this happens in Napier because my friend’s dad works for (...), they inject fruit to make it bigger...and looks good on the shelf” (25:57).

- *The importance of conserving natural ecosystems.* All seven participants were concerned about the harm human actions are causing to forests, animals, and marine life as well as valuing the need to protect critical natural entities and to support conservation efforts. SGD1 was worried about the environmental effects of the systematic clearing of rain forest in some parts of the world affirming, “if we go the same way we are going now, we won’t have any forests due to human effect” (1:27). SGD2 was concerned about the effects of deforestation on animals confirming, “That is a big deal as well, because it is killing their habitat” (5:16), while SGD6 added, “That will also affect the amount of oxygen produced” (2:30). SGD7 was concerned about marine life asserting, “I am concerned about overfishing in our waters” (3:10). SGD2 was also worried about the methods used in fishing explaining, “The majority of fish and other sea life is caught in the net as well, so that is affecting dolphins and things like that, not just the fish” (3:20).
- *Dealing with the issue of waste.* The students displayed responsible environmental views in highlighting the negative effects of waste and litter on the environment. Two participants were concerned about the consequences of littering. SGD4 stated, “I have always been concerned about rubbish and litter...I think that litter and rubbish are a huge issue”

(3:50). SGD5 was worried about the size of landfill areas in the region explaining, “it is coming to a point where we start to burn it as there is no place to put it...but there is like polystyrene, it doesn’t decompose and they can’t burn it because it goes up in the atmosphere” (17:01). The same participant then compared the potential consequences to living in, “Third World countries, masks all over our face and not able to breathe in a polluted environment.” (17:10).

(2) *The need for environmental awareness*

The student participants emphasised the importance of public environmental awareness through supporting and fostering environmental knowledge at home and in the community. The participants believed a change in attitude towards knowledge of ecology to be key to the survival of the human race. There was a firm belief in the valuable role of environmental education and ecological programmes in schools, particularly at high school level, as they felt this is lacking. There was a strong call for observing green ethics, especially in relation to animal treatment, valuing animal life, and the unethical practice of using products from deforested areas.

- *Promoting environmental education and ecological programmes.* All participants deemed environmental education essential to the sustainable future of the planet. SGD4 felt the importance of starting environmental education with children stressing, “Like me, I taught my children to recycle so as when you finish something like the milk bottle...you wash it out...then, you know, take it out. I feel that people need to be more vigilant” (28:12). SGD5 remembered a particular day at primary school, “we were taken to the recycling plant and out to the landfill when I was at Year 3 to show us what they were doing” (29:48), going on to say that the visit had left a vivid memory. SGD1 also commented on time at primary school in relation to ecology stating, “In the school I went to, in the UK, there wasn’t a lot of stress on the environment...and how to think about the future” (30:53). A fourth participant SGD2 stressed the need to educate the public about healthy food choices explaining, “Just look at people in

the supermarket and see how big they are getting...their trolley is just filled with processed food, hardly anything that is good for them” (39:41). SGD7 concurred stressing, “especially young generation, that is so important” (41:14).

- *Observing green ethics.* Participants demonstrated attitudes of stewardship and green ethics regarding animal liberation, demonstrating knowledge of human ecological footprint, and social ecology. SGD2 was annoyed at the way marine animals are treated in Sea World Park in the Gold Coast of Australia explaining, “They are keeping them in small cages, like in a small area, when they should be out in the ocean” (3:20), while SGD4 stressed, “It is really sad how a lot of humans don’t value animal, bird, and fish life as much as our own...their problem is that they are not aware” (5:54). SGD2 took a personal stance on the issue of animal mistreatment by changing habits “...[I] became vegan, I don’t eat anything that comes from animals anymore” (14:14), while SGD4 referred to an account of a meat processing factory stating, “...X has been telling me about what goes on there and it was just insane and horrific...I understand people need to eat and bla-bla-bla but at what cost!” (14:53). SGD2 condemned the use of crops from deforested fields, such as palm oil, declaring, “I also think about what is in the chocolate, that it is palm oil and stuff” (41:21).
- *Learning from traditional methods.* Two participants observed the modern trend for overreliance on technology to resolve problems calling for resurrecting and researching traditional methods, especially those that deal with climatic and environmental issues. SGD6 called for educating the younger generations and the need to “stimulate them to learn about...ways of older people of organic living and stuff” (36:42), while SGD4 stressed the unique qualities of traditional ways in “trying to be self-sufficient” (37:09).

(3) *The need for environmental action*

The student participant group shared a sense of responsibility for acting environmentally at community level due to general concerns about the consequences of population growth and excessive use of resources. They felt the stress these are placing on space and natural reserves that needs to be acknowledged more forcefully in order to raise awareness and influence people's behaviour. Promoting community-based sustainability projects was seen as an active way to engage people in sustainable action. The group thought about the importance of preserving natural capital through actions to preserve wild life and natural habitat. To do this they considered action to enhance public environmental knowledge was essential.

- *Promoting community-based sustainability projects.* Four participants were keen on supporting community sustainable projects. SGD6 believed in opportunities for a piece of land collectively gardened by the public, "I just wonder why people don't grow trees; orange trees or other fruit trees, if the climate allows" (42:21). SGD5 saw some difficulties in doing this as big companies control the trade of food products stating, "People don't do that because they can get cheaper price from import[s]...it is all about making that profit" (43:23). SGD4 felt a sense of duty to do more, also highlighting the role of the media to educate and inform stating, "...Why don't they give them the key to change instead of just reporting? ...This is happening here, and in order to change it this is what we need to do" (44:17). SGD4 also believed that people can use their time to do something useful such as growing food insisting, "Let's use the energy to make our own vegetable garden or something like that, it is much easier, we don't have to go to the supermarket to get food to eat, let's go to our backyard" (50:47). SGD2 was similarly motivated affirming, "Let's do it then!" (51:10).
- *Act to preserve wild life and natural habitat.* Participants believed in the significance of protecting and restoring places for nature. Two were convinced that now is the time to act and address these issues. SGD5 was

worried about the potential loss of wild life and animal habitat coupled with the effects of water and air pollution as a result of human activities and climate change affirming,

“I feel that most people...can’t see what is happening now and not looking forward to these times when...we will be losing wild life and plants, you know, all these grounds will be polluted and you can’t plant anymore because you can’t grow” (12:40).

SGD4 drew attention to the importance of saving animal habitat and wild life stressing, “Just because they can’t speak and deal with things the way that we do doesn’t mean that their lives are worth less than ours” (5:54).

- *Act to enhance public environmental knowledge.* SGD5 was deeply concerned that if humans continue with current consumerist practices, the future will be one of doom, unless an effort is made to change current living patterns and practices saying, “because we are left with no option but to change our lifestyles to suit the environment” (9:58). That participant also observed that we “are playing with things we don’t know how to handle...we are so focused on us now and not about things ahead” (21:02). SGD2 highlighted the need for leadership in informing the public, especially young people, about sustainable ways of living stressing, “I think this whole thing revolves around leading by example, if we can get more people not to ignore what is going on and understand it, kids will live that way...if you teach your kids to eat or live like that, they will eat or live like that, you start it early” (39:41).

This again stressed the need for awareness, education, and information to help solve current environmental and health problems.

7.3.1.4 Conclusions

This section reports findings from a group of students who chose to take part in the branding and graphic design of the LCP. For a qualitative focus group of seven participants is relatively small, but the information gained was again rich,

and diverse. Through analysis, it was possible to identify clear themes from the data. This made it possible to uncover values expressed in the students' opinions and reflect on their comments so to make an assessment of what sustainability meant to them as individuals.

Observations of the students' common reactions to unsustainable practices, particularly in relation to animal treatment, human health concerns, and a feeling of anxiety about the future of upcoming generations, suggested the participants had a strong passion for sustainability and a motivation to be sustainable. For some, the intent to try to influence others to behave sustainably and be ecologically sustainable demonstrated evidence of empowerment and readiness for environmental action in the community. Comparisons of emerging themes with those observed in the first design group will be discussed in Chapter 8.

7.3.2 Pre-engagement graphic design student survey

The whole 25-student cohort completed the same written survey as that given to the student designers (Section 7.1.2). Comparisons between groups who did and did not take part in the LCP graphic design are in Section 8.1.3.

7.3.3 Post-engagement focus group analysis

All participants were invited to take part in a post-engagement focus group, again to observe whether taking part in the LCP graphic design had any influence on their environmental attitudes, or sustainable behaviour. Indications in change to participants' knowledge of sustainability and their opinions about the issues involved were also sought.

7.3.3.1 Participants and procedure

Two post-engagement focus groups were conducted with the seven student participants subsequent to their involvement with the LCP graphic design. The first took place four months after the pre engagement focus group and involved five participants (SGD1–SGD4, and SGD6). The second with SCD5 and SGD7 was conducted eight months after the pre engagement focus group because at the

time the first focus group was held these two participants were unavailable for course related reasons. Both discussions were aimed at exploring responses to the initial two questions: *How concerned are you about the harm that humans are causing to the environment? Looking ahead to the year 2050, are you concerned about the environmental problems in relation to each of the following valued object groups: the biosphere, yourself, and other people*, together with the new question: *Did the experience of being involved in the graphic design of the LC project affect the way you acted recently in relation to sustainability?*

The two sessions took place in a lecture room on the EIT campus, with an hour set aside for each. The first session lasted 50 minutes and the second 23 minutes. Besides the author another non-participant student sat in on the first session but his/her comments have not been included in the analysis. The author was the only non-participant present in the second session. In both occasions the discussion was recorded with the permission of the group.

7.3.3.2 Data analysis

The same thematic analysis process was used (Braun & Clarke, 2006), with times of quotes extracted from the first focus group (recorded from 1st – 59th minute) and from the second discussion (recorded from 60th – 83rd minute).

7.3.3.3 Results

Transcripts of the focus group discussion, which identified each student's contribution, were used as a basis for analysis. From these two themes emerged:

- (1) Has the intent to act sustainably, and
- (2) A wish to motivate others to act sustainably (Figure 7.5).

Figure 7.5 Final thematic map for student graphic designer post-engagement focus group themes.

The following is a discussion of each individual theme, along with the specific sub-themes within it.

(1) *Has the intent to act sustainably*

The participants demonstrated deeper environmental knowledge as a result of their involvement in the graphic design of the LCP. This is particularly evident in showing pro-environmental attitudes towards preserving material resources and awareness of the importance of saving energy through employing sustainable approaches in the building and operation stages. There were also concerns about the well-being of future generations as a result of currently perceived irresponsible human practices.

Through electing to take part in the LCP, the participants demonstrated willingness to engage in a sustainable project. Their post-engagement comments also show development of responsible environmental attitudes, especially in relation to sustainable material choices, recycling, transport (opting to cycle to work), and ensuring that every day activities have minimum impact on the environment. Participants were keen on using organic food growing methods and discussed establishing vegetable gardens both to help supply food for families and to reinforce traditional home practices. A number of participants confirmed their stance towards animal well-being by not eating meat. Many also talked about their healthy diets.

Participants also saw the cultural and historic dimensions of the Otatara site as a significant element of the project and an important reason for taking part. They were motivated by the opportunity to inform others about the history of the place.

- *Demonstrating deeper environmental knowledge.* All seven participants affirmed that taking part in the LCP provided them the opportunity to extend and deepen knowledge about sustainable and ecological practices. SGD3 displayed improved environmental knowledge when declaring a

sustainable building to be one “that produces no emissions.” (6:37), and SGD4 described it, “Basically to me it feels like a self-sufficient building that is not relying on outside sources” (6:41). Referring to the waste treatment facility at the LCP that uses the effluent to grow plants in the greenhouse, SGD4 also affirmed that sustainable buildings “have to be self-sufficient, but help the environment as well” (8:40). SGD2 expanded on the idea of the ability to grow food stating, “I also think of it as not just a building...but having the plants in it as well, in the green house; you know fruit, veggies, your own sources” (9:05). SGD6 also stressed the environmental advantages of growing food locally adding “And also you don’t have to travel, as that may cause pollution!” (10:14). In pointing to the nature of the LCP and the knowledge gained as a result of taking part in it, SGD1 stated, “I saw that it is a real life project and a good way to learn about a lot of things, now I feel like I know a lot more” (46:57). In support, SGD4 added, “it has taught me a lot about the environment and that there are changes, even I can make to do my part” (47:16). SGD2 felt that the LCP as a teaching facility made up for the loss of the Arts Centre, which was once on the Otatara site, and that the LCP could now be seen as an continuance of it, explaining, “it is not there anymore, but there could still be teaching and learning that take place up there. That really inspired me to brand it well and inform the people about it” (47:50). SGD5 was influenced by the project’s emphasis on recycling affirming, “and that sparked it for me; when you recycle and you show the product that you can get from recycling” (62:21). SGD7 wanted to increase knowledge about sustainability in order to find ways of making a difference in the community, “I already knew a bit, but I also want to learn more about it to see how I can make a difference” (69:30).

A number of participants were also influenced by the LCP design concepts and retrofit solutions. SGD2 was inspired by the sustainable techniques used in the LCP to the degree of deciding to adopt them in the future affirming, “when I am doing my own house I am going to do it

exactly the same way; I am going to use the same solar panels and try to have it as clean as possible” (3:00). SGD7 was influenced by the objectives of the LCP in offering inspiration to others explaining, “it’s kind of made me branch out and help people, even if there is no benefit, because you don’t know how this can change somebody’s day” (65:35). As a consequence of taking part, SGD5 decided to walk to work instead of driving, as well as offering to do design work for Environment Centre HB (a local group who runs sustainability programmes), by saying “they are having their night on the 11th of April so I am going to design a poster for that” (61:20). SGD1 acted in a pro-environmental manner with regard to saving energy and the use of A/C technology for interior comfort, “I need to be conscious whenever I use the Air Con. I use the windows and stuff first, yeh” (7:50).

On the subject of preserving natural resources, participants SGD1–SGD5 and SGD7 demonstrated in-depth sustainability knowledge through expressing concerns about current consumerist practices. SGD1 observed, “There are new phones every 18 months and the old phone just goes in the bin, it is just a waste” (22:38). Commenting on using recycled structural elements in the LCP, SGD7 stated, “I wasn’t sure whether other sustainable projects had actually used recyclable materials to build the structure in which they are going to teach sustainability” (69:40).

A number of participants (SGD1, SGD2, SGD4, and SGD5) expressed profound environmental concerns about the future due to the extensive use of resources. SGD1 declared deep personal concerns about her own future and that of possible future children explaining, “if we continue on the destructive path that we are on because there not going to be enough left by the time that I have kids” (30:27). SGD2 demonstrated ecological sensitivity through concerns about the overuse of fertile land for animal farming, explaining,

“We destroy so much land or crops for the animals to be fed, and we feed them so much and they get killed, but that same amount of crops can feed so much more humans. Then the animals are getting eaten having to eat, so it is kind of another money making process...if that makes sense” (38:14).

Later, SGD5 affirmed that the potentially devastating effect of climate change was a driver of being passionate about sustainable activities, “if we don’t pull our fingers out and start making a change, this place is going and trees are going down and all this, climate change is real” (70:48).

- *Prepared to act sustainably.* For many participants, taking part in the LCP was motivation to want to carry out responsible environmental actions. Participants SGD1–SGD5 and SGD7 previously held strong environmental values but taking part in the graphic design project was a factor in expanding and deepening their passion for sustainability, the environment, and humanity, especially concerning sustainable living practices, recycling, retrofitting, and electing to choose sustainable materials. An example is SGD7’s attitude to opt for the organic when it came to fabric choices asserting, “It kind of inspired me within my practice, because I am into textile design and fabrics. So I want to use organic fabrics and sustainable products, yeh” (66:38). With regard to building, this same participant was now keen on adopting sustainable practices especially refitting and having a long-lasting outcome, aiming “to use recycled products and to limit the waste. To build something that is going to last” (73:45). The same participant also stated the project changed transport use stating “...and also walking to work instead of driving to work” (61:20).

Showing intent towards environmental action, participants SGD2, SGD4, and SGD5 called for wider utilisation of the LCP refurbishment ideas in terms of recycling waste, saving water, and having a positive environmental influence on the community. SGD5 demonstrated

personal commitment to the LCP by offering to assist in the building works as well as the graphic design, “I just saw you doing it just by yourself and I didn’t see anybody else so I just wanted like to help you out in the situation” (63:55). This same participant showed a strong environmental attitude in suggesting methods of raising funds for the project building works advising, “Yeh, yeh, yeh, there is like Kick Starter and all that, that you can apply” (65:17).

On the subject of the ability to grow food at home and protect animals, SGD2 supported and valued environmental education at home and the advantages of growing food organically commenting, “no sprays nothing, you know yourself you have got nothing on them and it is like an achievement as well” (9:39), while SGD4 endorsed the pleasure of autonomous living and made a personal commitment to growing food explaining, “If you become self-sufficient, you know the journey of that food, where did it come from and how it is treated” (10:21).

- *Support the connections between culture and ecology.* Four participants; SGD2, SGD3, SGD5, and SGD6 considered cultural and historic aspects as significant elements of the LCP. SGD2 was particularly passionate about the rich history of the Arts Centre at Otatara and decided to go beyond the branding brief and make a movie about the history of the Otatara site, “When I was doing the movie, what really got me was just to appreciate the things that were around, because it just makes me sad that although these buildings were taken down and the log cabin was the only one left” (3:00). SGD3 was also influenced by the history of the place stating, “I just saw the rich history in it and I dearly wanted to restore that” (46:39). SGD6 also had feelings connected to the project’s location stating, “I just wanted to contribute something towards this place as I felt I was connected with it” (48:43).

(2) *A wish to motivate others sustainably*

The student participant group realised the importance of community environmental education, particularly valuing the educational dimension of the LCP. They also appreciated the difficulty of changing living practices given that people are brought up to particular ways of living. They were committed to sharing organic and healthy living practices with others. Many believed that to influence change in the community children have to be educated about sustainable practices, especially in the home and at a young age. They also called for the protection of animals, particularly those raised in industrial farming.

The participants also influenced sustainable action in the community through establishing personal social media blogs, sharing sustainability matters, and motivating others to eat healthily. Participants called for recycling and mending instead of replacing articles. They wanted to show children how to adapt to the unexpected and learn how to deal with new circumstances in a sustainable and environmentally responsible manner. Participants also called for community action in terms of establishing community vegetable gardens and emphasising the position of projects like the LC in the community. The student participants also highlighted the important role of the various media platforms in informing and educating the public about sustainable actions.

- *Intent to educate others ecologically.* SGD1, SGD2, and SGD4 acknowledged that people become accustomed to particular ways of living or a particular diet that they would find difficult to change to a more sustainable or healthier one. SGD1 was critical of those who think that environmental tragedies are far-off and believed that if adversity occurs as a consequence of an environmental effect “even that, some people will still deny it and say, ‘I don’t see the relevance of it’ or ‘Oh, it doesn’t relate to me’...” (42:11). SGD2 displayed knowledge of environmental action strategies by starting a YouTube blog and a Facebook page sharing with others healthy and vegetarian diet options stating, “We always share things on our Facebook about not eating meat” (16:27).

SGD2, SGD4, SGD5, and SGD7 supported and valued environmental education at home, in particular introducing children to sustainable practices, as well as the importance of educating the community about ecological practices. SGD4, believing in the importance of education at a young age commented on responsible environmental practices, “starting earlier, making younger people more aware of...these issues and really explaining it to them, because I know nobody has explained to a child that if you cut down a tree you are taking away somebody else’s home, you know” (14:27). On another note, SGD7 recognising the potential significance of the educational dimension of the LCP for the community stated, “It is important because it is a place for people to go and learn. It is a place to host workshops” (72:03). SGD5 affirmed this as “Extremely important” (72:22), and continued by commenting on the location as the perfect place for education affirming, “It is like the place that it is, made so much for what you are trying to put out” (72:45).

SGD2 and SGD4 put forward a strong green message regarding the mistreatment of animals, demonstrating deep green beliefs. SGD4 said humans had a duty to protect animals,

“It is very sad...a lot of people’s concept that human life is more important than animals’ or an insects’...we have that intelligence to choose to use it to realise that we should care for these things instead of just destroying them” (12:41).

As a final year project in the following year student SGD1 designed ‘Enviro Game’. This was an electronic game aimed at educating children about sustainable practices influenced by the LCP objectives.

- *Contribute to influencing sustainable action.* SGD1, SGD2, SGD4, and SGD7 were motivated to influence sustainable action in the community. In developing ideas for the branding of the LCP, the students initiated a Facebook page, additional to the requirements of the brief, in order to

have a communication channel to post updates on the LCP progress and inform the community about the project's development. SGD7, stimulated by the LCP message of sustainable living, was also able to motivate family members and friends to eat healthily stating, "so from doing that [being involved in the LCP], I have motivated other people to eat unprocessed food and things like that as well" (60:58), later explaining 'other people' meant, "family members and friends" (61:20).

Participants also called for recycling and mending instead of replacing the whole article. SGD1 explained the need to replace faulty parts rather than throwing the entire gadget away, "if your battery is gone, you just replace the battery" (23:24). Subsequently, SGD4 called for adopting replacement in product design asserting, "It is an interesting design idea and I think people are thinking about it" (23:30).

SGD1, SGD4, SGD5, and SGD7 also supported the practice of domestic and community organic food growing, pointing out its collective environmental benefits. SGD4 stressed, "If everybody grows their fruit and vegetables, we are going to save a lot of damage to the atmosphere from the emission it produces to harvesting the vegetables and you don't have to ship it to places" (10:21). In support of community environmental actions, SGD1 followed, "It is also builds a sense of community" (11:17). The same participant firmly believed that working together as a community is the way to overcome environmental problems, thus showing a personal desire for environmental issue resolution. SGD5 later endorsed educating the community about the benefits of sustainable living and saw the LCP as presenting a new way of thinking stating, "It makes it a lot stronger as an idea; your sustainable building is built sustainably, and run sustainably" (75:06).

- *Aware of the role of the media in community education.* SGD4 believed the media should show examples of sustainable buildings as normal living practice

rather than just as innovative concepts commenting, “and you see a write up in the NZ Home and Garden magazine about people living completely sustainable...and you put the magazine away and carry on living, you know. These things that should be normal are being showcases...” (25:40). On another note, SGD2 was critical of the media, as well as social media, in supporting and highlighting *life style* topics over *sustainability* ones, believing that the media have their own *consumerist* agenda.

7.3.3.4 Conclusions

This section reports the findings from a group of students following their involvement in the LCP in its branding and graphic design. The group was small for a qualitative focus group (5 participants) and interview based discussion (2 participants) but again useful and consistent themes emerged.

This participant group demonstrated a strong passion for sustainability through producing more work than required to meet the LCP graphic design brief. This is evidenced through initiating ‘The Log Cabin’ Facebook page they created to post updates on the project progress and the documentary film they made about the history of the Otatara site designed to be shown to LCP visitors. They thus demonstrated inspiration, intent to act, and vision influenced by the historic, social, and cultural dimensions of what was present in the LCP environs.

For many, the intent to try to influence other individuals and the wider community to adopt responsible, healthy, sustainable, and ecological living practices, such as promoting gardening, was clear evidence of empowerment and readiness for environmental action in the community.

The group felt very strongly about extending environmental education in schools beyond junior levels, realising the significance and criticality for future generations of acquiring in-depth knowledge and environmental awareness. In relation to this, and being media students, they understood the role of the media in educating the public about ways of living and behaving sustainably.

Holding such high environmental values and qualities also offered an insight into why this group of individuals decided to take part in the project. The discussion around this took a slightly different direction in terms of what emerged being not so much about the *project*, but rather about the *people*. It seems this group has been inspired to embrace sustainability, and illustrates what might come out of this experiment in terms of the potential leadership demonstrated by this group of students, despite different levels of participation in discussions.

7.4 Project volunteers

As mentioned before (Section 6.9.5) a number of volunteers from EIT and elsewhere worked on finishing the LC. Some were paid but not at a full rate. This section reports on the findings from focus group discussions and interviews with a tutor and two students from the Trades programme, two technicians from the VAD programme, and a student from the Screen Production programme at EIT. Particular emphasis was put on the question: *What was your motivation for taking part in this project?* Transcripts of the discussions, which identified each participant's contribution, were used.

7.4.1 Builder volunteers

Trades programme students at EIT made a notable contribution to the LC building work as part of their 'work experience' course requirements. However, a building tutor volunteered to help to finish the LC roof in his own time. The same tutor asked his students to help build the greenhouse and two took up this opportunity, helping with the greenhouse foundation, concrete slab, and timber framing works during their two-week mid-year break.

A focus group was conducted with the tutor and two students. The tutor was motivated by the ecological objectives of the project that correlated with the attitude of 'care' for the environment explaining, "It is a small scale, but it is about education, and, you know, putting it out there." The tutor continued, "As an individual, I care, and as soon as you get that factor in it, people start to buy into it, and all of a sudden, we are healing the world." Both student participants were

keen on recycling, one stating, “certain stuff that you recycle, you can use again, which keeps the environment clean by using less resources.” The second commented, “The project opened my eyes to a different type of building.” The same student continued, “Recycling, my mum taught me to recycle and why recycle.”

7.4.2 VAD technician volunteers

Two technicians in the VAD programme helped in their own time. The first undertook to repair and paint 18 window sashes (610x1830mm), which the author had bought from a second hand building supplier and stored in the EIT wood workshop. The Head of ideaschool® at EIT asked the second technician to help with the LCP for one afternoon, but inspired by the project objectives, the technician worked for eight days to building the interior frames and lining.

A joint interview was conducted with the two VAD technicians. When asked about their motivation, the first technician saw it as a matter of helping someone in need stating, “For me, when you turned up with all these windows for the greenhouse, I looked up at this daunting task and had to tidy them up.” The second technician, who initially agreed to help on being asked by the manager, affirmed, “you see a need and you do it.” He also stated, “If it was something damaging to the environment, I wouldn’t get involved.” Also, commenting on personal feelings when the project started taking shape, “you can see the vision more clearly when there is something happening there, and it is more interesting.” Both technicians emphasised the significance of taking action in terms of the practical engagement with environmental tasks. On that subject, the first technician recounted individual experience when the institution was planning to have a sustainable building on campus in 1986 stating, “I have always been interested in sustainable technologies...I went to one of those meetings, and it ended up being a big talk about anything other than putting a windmill or a sort of solar generator, but that is all I was interested in, the hands on side of it, something that would generate power.” The second technician reflected that idea describing his experience in relation to the LCP, “Sustainability is often

something that is talked about a lot and you read about it in other places, but it is great to see it do-able in your backyard. That could be a reason why I decided to continue helping you.”

7.4.3 Documentary volunteers

A Year 2 student in the Screen Production programme chose to shoot and record a documentary on the LCP after a tutor in the programme mentioned it and its objectives. The aim was to provide a record of the past and the future of the project. The documentary included two interviews; one with the builder of the original log cabin B1 telling the story of its beginning, thus representing its past, and the other with the author telling the story of its retrofitting, representing its future as a demonstration facility. This was the second documentary made on the LCP. The first was by the SGD students in the VAD programme a year before (see Section 6.9.2).

The student’s motivation emanated from personal environmental concerns especially about limited global resources, over population, non-organic methods of growing food crops, and the future of upcoming generations stating, “we are living at the end of an environmentally kind of stable era, we arrived at the right time to receive the benefits of industry but our kids will arrive at a time when they have to pay the price.” The student’s attitude concerning sustainable living was influenced by personal upbringing at home, explaining, “We live in the middle of Hastings and we have a veggie garden and we have fruit trees and citrus trees. We have solar panels on top of our shed...to supply the electricity that we need.” The student clarified that the solar panels were first installed to heat the swimming pool, but later utilised to generate the electric power needed in the house.

7.4.4 Conclusions

The motivation for most volunteers discussed above was to express their passion for nature and ecology. The project refurbishment works mainly relied on sponsorship and contributions from a number of passionate individuals who gave

a lot of time and energy to the project. The nature of the project in being the retrofitting of an existing building that was neglected but with a history that people could identify with was significant for the volunteers. Sustainability was important in inspiring individuals to do something tangible and beneficial for the well-being of the community. Moreover, because the project was part of an education institution, it gave the project status and a place that related to teaching values.

7.5 Management

7.5.1 Managers support for the LCP

Once the project started to have a presence, seven people from the EIT management were invited for a visit, separately or in groups of two. Upon witnessing the progress, they decided to support the LCP in different capacities. The Head of EIT ideaschool® used part of the school's research budget for purchasing building materials while the Research Director at EIT was behind two separate \$4,000 grants (24 months apart) towards the construction in addition to becoming personally involved in certain building activities. Both managers were probed about their reasons for supporting the project in separate interviews.

Initially, both were motivated to back the project as part of their management role. However, as the project gained momentum and started to take shape, other motivations emerged. For the first manager, the fact that it was a sustainable building influenced the decision to support it as "it is important that everything we do from here on in has got that in mind because the world has changed." However, when the building was close to completion, it was realised that it would fit the institution's plans to redevelop the site, "We had an interest in redeveloping Otatara to reflect the importance it has had to the Art School and within EIT. I saw it as probably an anchor point for that redevelopment." The project's objectives of using it as a place, "where you can take schools to learn about sustainability...and the idea of an artist-in-residence accommodation" made the project more appealing, "now it is extremely important to finish it off, really."

The second manager who helped with the building works a couple of times and donated materials to the build stated, “I think the project itself is great in terms of the concept and what you want to do with it.” Following an earlier visit to the site, this manager was motivated to assist because; “a lot of it is done on donations or cut-rate services from other people. I thought, well, I have got a little bit of useful experience at times...that could be useful as well.” This manager was also influenced by the sustainable qualities of the project, emphasising, “I think sustainable buildings are a good idea, but they don’t seem, to my limited understanding...to be made to seem do-able to a lot of people.” So to take a building that, “was probably close to being derelict and turning it into something that is useful, sustainable, and green was inspiring.”

7.5.2 Conclusion

At the start of the project EIT granted permission to develop the LC to become a demonstration building with the condition that this would be at no cost to the institution (Section 6.2.1). However, as the project started to be physically tangible, the support of EIT and enthusiasm of individuals who chose to become involved became noticeable. The fact that management decided to support the project financially, including their willingness contribute to a contract for the plumbing works for the project, was significant.

7.6 Survey of visitor groups

The objective of this part of the study is to investigate the effect visiting a demonstration sustainable building might have on people’s attitudes to sustainable issues, and whether the methods for making a building more sustainable displayed in the LC affected how people thought about their own living environments.

The aim is to achieve an insight into the environmental attitudes of visiting individuals and their reactions to perceived environmental problems, and ultimately, whether these differed from those who had a more ‘hands on’ engagement with the LCP. It also set out to examine past and future

environmental actions regarding living environments. More specifically, it aimed, through a questionnaire based survey to:

- (a) Observe underlying differences in the three EC motives (egoistic, altruistic, and biospheric) among the different participating groups (Schultz, 2001) (Section 3.2.1),
- (b) Examine awareness of the biospheric, egoistic, and social consequences as indicators of environmental intentions (Joireman et al., 2001) (Section 3.2.2), and,
- (c) Investigate the 15-item New Environmental Paradigm scale as a measure of public concern for environmental quality (Dunlap et al., 2000) (Section 3.2.3).

7.6.1 Method

At the pre-visit phase, an anonymous three-part questionnaire was given out to 194 participants (93 males, 98 females, and 3 who identified themselves as other), with ages from 17 to 69 years ($M = 34.86$; $SD = 1.246$). This is the same questionnaire given to the student designers (Section 7.1.2) and the student graphic designers (Section 7.3.2). Later, between February and August 2016 visits to the LCP were organised in groups of various sizes. During the visit, these groups were informed about the project in terms of its initiation, historic links, objectives, refit practices, and future prospects. Afterwards, a second post-visit four-part questionnaire was given or sent electronically to all participants (Table 7.2).

	Section 1: EC ⁽¹⁾	Section 2: AC ⁽²⁾	Section3: NEP ⁽³⁾	Section 4: SA ⁽⁴⁾
Pre-visit questionnaire	✓	✓	✓	
Post-visit questionnaire	✓	✓	✓	✓

Table 7.2 Survey sections.

⁽¹⁾ Environmental Concerns measure (based on Schultz, 2001)

⁽²⁾ Awareness of Consequences measure (based on Joireman et al., 2001)

⁽³⁾ New Environmental Paradigm scale (based on Dunlap et al., 2000)

⁽⁴⁾ Sustainable Action questions

A total of 126 visitor participants returned the post-visit questionnaire (49 male, 75 female, and 2 other), with ages from 18 to 68 years ($M = 36.63$; $SD = 1.230$). The EIT Trades group of 15 participants did not return it, probably because the timing of the survey was too close to the end of their academic programme. Only 10 of the 23 pre-visit participants from the Environment Centre group did (Table 7.3).

	Visitor groups	Pre-visit (N)	Post-visit (N)
Group 1	EIT Staff	29	24
Group 2	EIT Students	54	31
Group 3	VAD Students	73	61
Group 4	Environment Centre	23	10
Group 5	EIT Trades	15	0
Total		194	126

Table 7.3 Participant visitor groups.

7.6.2 Surveys

In addition to demographic information (gender, age, and ethnicity), the pre-visit questionnaire was aimed at finding participants' level of environmental knowledge before the intervention (the visit to the LC). The post-visit survey was aimed at assessing whether the LCP visit coincided with an increase in environmental awareness or a change in attitude towards sustainability. Pre and post-visit questionnaires are shown in Appendices 5 and 6.

Section 1: Environmental Concerns (EC). Attitudes to environmental concerns were assessed using a 12-item scale measuring three categories of concerns about environmental problems caused by human behaviour (Schultz, 2001) (Section 3.2.1) ECs were indicated on a 7-point Likert scale (1 = not important to 7 = supremely important).

Section 2: Awareness of Adverse Consequences (AC). AC beliefs are causally related to value orientation where individuals select information choices they believe are consistent with their value orientation biases (Joireman, 2001). AC beliefs were

examined using a 13 statement scale measuring three facets of the Environmental Survey Scale (selected from the five facets in Joireman et al., 2001), (Section 3.2.2). All statements were rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree).

Section 3: New Environmental Paradigm (NEP). The set of 15-items are designed to measure the overall relationship between humans and the environment. This has been the most widely used measure to investigate environmental concerns (Dunlap et al., 2000; Dunlap & Jones, 2003), (Section 3.2.3). The eight odd-numbered items were worded so that agreement indicates a pro-ecological view, and the seven even-numbered ones so that disagreement indicates a pro-ecological worldview. All statements were rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree).

Section 4: Sustainable Actions. A set of 23 action statements at the post-visit phase aimed to find out what sustainable actions the participants had done or intended to do, and changes made as a result of their visit to the LCP. Actions were listed, such as “Install additional insulation in home.” Alongside each statement were three columns where participants needed to choose whether the action was done *before* the visit to the LCP, *because of what they have learnt* at the LCP, or was one they intended to do *in the future*.

7.6.3 Procedure

As mentioned above (Section 7.6.1), prior to the LCP visit participants were asked to fill in a pre-visit questionnaire. The student participants were given this in a classroom setting, while those for the EIT staff were delivered personally. For the Environment Centre group, questionnaires were completed on site before a presentation of the project’s objectives. All participants had to give their written consent prior to conducting the survey. Subsequent to the pre-visit survey, the participants were taken as group on individual tours to the LCP where the sustainable building practices, techniques, and the environmental solutions adopted were explained (the intervention). Later, 3–6 months after the

intervention, a post-visit survey was conducted. Questionnaires were handed to the student participants in a classroom setting, while the remainder were personally or electronically delivered.

7.6.4 Data Analysis

All data analyses were performed using SPSS (Statistical Package for Social Sciences), except as noted. Survey data were entered by hand into an SPSS file. The focus led to a parsimonious approach to the data, as the main goal was to explore change after the intervention. The pre-visit and post-visit data in SPSS was combined into one set. SPSS Syntax was created for running the main steps, which were later divided into sections for reporting. A (*p*-value) of <0.05 for all statistical tests performed was considered significant.

7.6.5 Reliabilities

Cronbach's alpha coefficients were used to assess the internal consistency of data. As a reliability coefficient, alpha is expressed as a number between 0 and 1. According to Nunnally's (1978) rule of thumb, instruments used in basic research should have Cronbach's alpha coefficients of 0.70 or higher. However, Clark and Watson (1995, p.315) noted, "...it is not uncommon for contemporary researchers to characterise reliabilities in the 0.60s and 0.70s as good or adequate." For a sample of a 100 or larger, Cronbach alpha coefficients greater than 0.40 are acceptable for research purposes (Mueller, 1986) (Table 7.4).

To assess whether a visitor's knowledge of each item in sections 1–3 of the questionnaire has increased, a paired t-test was used to compare the stated level of knowledge before and after the visit (Blaikie, 2003, p.183; Creswell, 2014, p.165). This included comparisons according to gender, age, and ethnicity. Analysis of variance (ANOVA) was performed on knowledge ratings for the main three visitor groups of VAD students, EIT students, and EIT staff, to look for significant differences. For Section 4 of the post-visit survey, percentage participant responses to targeted sustainable actions and future intentions were calculated using SPSS.

Measure	Pre-visit (T1)			Post-visit (T2)		
	N	Cronbach Alpha	No of items	N	Cronbach Alpha	No of items
EC egoistic	196	0.917	4	126	0.916	4
EC altruistic	191	0.864	4	119	0.886	4
EC biospheric	200	0.898	4	126	0.904	4
AC egoistic	190	0.579	4	121	0.570	4
AC social	195	0.632	5	121	0.724	5
AC biospheric	198	0.552	4	125	0.602	4
NEP	185	0.759	15	120	0.808	15

Table 7.4 Cronbach's alpha scores for seven survey measures from three sources, pre and post-visit.

7.6.6 Statistical analysis

Of the 194 participants who completed the pre-visit questionnaire, 126 filled in the post-visit survey, a response rate of 65% (Table 7.2).

7.6.6.1 Demographics

Survey participants were 48.0% male, 50.5% female, and 1.5% other. They were predominantly NZ Europeans (65.9%) followed by Māori (21.1%). A review indicated 44.8% of visitors were aged 17–25, which is expected given the student contingent but there were no noticeable differences with regard to gender (Figures 7.6 and 7.7).

Figure 7.6 Ethnicity and gender of pre-visit participants.

Figure 7.7 Age and gender of pre-visit participants.

7.6.6.2 Descriptive Analysis

Descriptive analysis involves the Means, Standard Deviations, and Alpha values of the seven measures (the three Environmental Concerns measures, the three

Awareness of Consequences measures, and the NEP scale). Tables 7.5, 7.6, and 7.7 compare the Mean, Standard Deviation, and Cronbach alpha results with results from similar studies. Due to having different scale ranges in Table 7.7, Mean values were converted to the percentage of maximum possible score (POMP) for comparison (Cohen et al., 1999; Fischer & Milfont, 2010).

	Schultz ⁽¹⁾ N = 1010		Milfont et al ⁽²⁾ N = 658		LCP Visitors N = 196		Cronbach Alpha reliability value		
	M ⁽³⁾	Std dev ⁽⁴⁾	M	Std dev	M	Std dev	Schultz	Milfont et al	LCP Visitors
EC: Egoistic Concerns	5.47	1.51	5.36	1.29	5.58	1.44	0.71	0.90	0.91
EC: Altruistic concerns	5.78	1.49	5.77	1.14	5.98	1.37	0.64	0.88	0.85
EC: Biospheric concerns	5.33	1.38	5.44	1.05	6.22	1.07	0.86	0.89	0.89

Table 7.5 Environmental Concerns: comparisons of Means, Standard Deviation, and Reliability for Schultz (2001), Milfont et al. (2006), and LCP pre-visit surveys.

⁽¹⁾ Selected results from (Schultz, 2001, p. 329), ⁽²⁾ Selected results from (Milfont et al., 2006, p. 753), ⁽³⁾ M=Mean, ⁽⁴⁾ Std dev=Standard Deviation.

	Joireman et al. N = 191		LCP Visitors N = 196		Cronbach Alpha reliability value	
	M ⁽¹⁾	Std dev ⁽²⁾	M	Std dev	Joireman et al.	LCP Visitors
AC: Egoistic consequences	5.48	0.95	5.82	1.34	0.67	0.57
AC: Social consequences	5.53	0.93	6.10	1.25	0.76	0.63
AC: Biospheric consequences	5.22	0.97	5.53	1.54	0.65	0.55

Table 7.6 Awareness of Consequences: comparisons of Means, Standard Deviation, and Reliability for Joireman et al. (2001) and LCP Visitors pre-visit surveys. ⁽¹⁾ M= Mean. ⁽²⁾ Std dev= Standard Deviation.

New Ecological Paradigm (NEP) items and item numbers		Amburgey and Thoman ⁽¹⁾ N = 328		LCP Visitors N = 185		Amburgey and Thoman	LCP Visitors
		M	Std dev	M	Std dev	M _{POMP score} ⁽²⁾	M _{POMP score}
NEP 1	Limits ⁽³⁾	3.13	1.28	4.97	1.56	53.25	66.17
NEP 2R	Anti-Anthro	3.14	1.11	4.86	1.61	53.5	64.33
NEP 3	Balance	3.62	1.08	5.18	1.57	65.5	69.67
NEP 4R	Anti-Exempt	3.22	1.02	4.17	1.62	55.5	52.83
NEP 5	Eco-Crisis	3.91	1.07	5.84	1.30	72.75	80.67
NEP 6R	Limits	3.09	1.21	2.88	1.66	52.25	31.33
NEP 7	Anti-Anthro	4.05	1.11	6.28	1.12	76.25	88.00
NEP 8R	Balance	3.74	1.08	5.32	1.59	68.5	72.00
NEP 9	Anti-Exempt	4.33	0.81	5.75	1.29	83.25	79.17
NEP 10R	Eco-Crisis	3.44	1.17	5.18	1.61	61	69.67
NEP 11	Limits	2.48	1.23	5.12	1.58	37	68.67
NEP 12R	Anti-Anthro	3.02	1.45	5.44	1.75	50.5	74.00
NEP 13	Balance	3.02	1.45	5.36	1.50	50.5	72.67
NEP 14R	Anti-Exempt	3.62	1.12	4.44	1.69	65.5	57.33
NEP 15	Eco-Crisis	3.57	1.16	5.70	1.40	64.25	78.33

Table 7.7 Comparison of NEP scale in Amburgey & Thoman (2012) and LCP Visitors pre-visit surveys.

⁽¹⁾ Amburgey & Thoman (2012, p.239) used a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree), while LCP Visitors used a 7-point Likert scale (1=Strongly Disagree, 7=Strongly Agree).

⁽²⁾ POMP (percentage of maximum possible) score

⁽³⁾ Limits = Ecological limits, Anti-anthro = Human domination, Balance = Balance of nature, Anti-exempt = Human exemption, and Eco-crisis = Ecological catastrophe

7.6.6.3 Correlations

Simple correlations were computed between all seven measures, pre and post-visit and evaluated using two-tailed tests. All relationships were reported in a correlation matrix (Appendix 11).

General inspection of the correlations revealed the NEP measure (Section 3 of the questionnaire) were strongly associated with the rest of the measures ($p < .01$ in all correlations), indicating that its variables are closely associated, albeit to a varying extent, with the outcome variables of both Environmental Concerns (AC) and Awareness of Consequences (AC) measures. It seems the post-test NEP measure is particularly correlated with the three AC post-test measures: Egoistic Consequences ($r = .28, p < .01$), Social Consequences ($r = .57, p < .01$), and Biospheric Consequences ($r = .59, p < .01$). Consistent with the biospheric considerations, biospheric concerns were, as expected, strongly correlated with biospheric consequences ($r = .24, p < .01$). Further inspection revealed that, as anticipated, egoistic concerns were strongly associated with altruistic and biospheric concerns ($r = .68, p < .01$ and $r = .45, p < .01$ respectively).

7.6.6.4 Comparison with pre-visit survey results

All five groups who visited the LCP recorded their responses to the seven measures at the pre-visit stage. The means were adjusted for each variable using Estimated Marginal Means (in SPSS) in order to allow comparison of the means of unequal sample sizes (as in ANOVA) (Appendix 12).

Comparing the Mean (M) for the participant groups pre-visit, itemised with the associated Error Standard (ES), against the seven measures (Figure 7.8, based on Appendix 12), revealed that in relation to egoistic measures of both EC and AC, EIT Students achieved the highest average means in ECs ($M = 5.65, SE = 0.19$) and VAD students the highest in AC ($M = 5.93, SE = 0.10$), while at the lower end of the EC measure the four groups were close, with VAD students the lowest by a small margin ($M = 5.51, SE = 0.16$) while EIT Trades had the lowest AC measure ($M = 5.11, SE = 0.23$). For altruistic and social measures of EC and AC, EIT Staff and the Environment Centre had the highest average means ($M = 6.23, SE = 0.20$ and $M = 6.17, SE = 0.16$ respectively), and EIT Trades the lowest in both measures ($M = 5.56, SE = 0.29$ and $M = 5.53, SE = 0.20$ respectively). For biospheric measures of both EC and AC, VAD students attained the highest

averages in both measures ($M = 6.46$, $SE = 0.10$ and $M = 5.81$, $SE = 0.11$ respectively) with EIT Trades having the lowest in EC measure ($M = 5.53$, $SE = 0.23$) and EIT students the lowest in AC measure ($M = 5.17$, $SE = 0.13$). Finally, in relation to the NEP scale, the Environment Centre group achieved the highest average mean ($M = 5.44$, $SE = 0.14$) and EIT students the lowest ($M = 4.68$, $SE = 0.09$).

Figure 7.8 Estimated marginal means responses to each of the five main groups at the pre-visit stage in relation to the seven measures: the three ECs, the three ACs, and NEP.

In order to find out the highest means, and hence the most pro-environment visitor group, means of the seven measures for each of the five groups were averaged. The Environment Centre group had the highest average mean of ($AM = 5.87$) followed very closely by VAD students ($AM = 5.86$), while the EIT trades group had the lowest average ($AM = 5.35$).

Being a committed environmental group that people elect to join, this result was expected. Although they were not the highest in all comparisons, they were close to the top in most measures. The results also showed that the VAD student group, a mixture of visual arts and design students, had a similar knowledge of and passion towards sustainability issues and the environment.

7.6.7 Results and discussion

7.6.7.1 Paired-sample t-test

A paired sample t-test was used to analyse and compare the mean difference for responses to the seven measures before and after the visit (Statistics Solutions, n.d.). Comparisons (*t*-test) of these responses indicated a marginal increase in knowledge in all the measures except the AC Social Consequences category (Figure 7.9). In general, it seems participants already had a reasonably high level of knowledge about a variety of sustainability topics, which is evident in the relatively high pre-visit mean scores.

Figure 7.9 *t*-test paired sample statistics. Mean responses to the seven measures. N = 126. EC = Environmental concerns (Schultz, 2001), AC = Awareness of the Consequences (Joireman et al, 2001), and NEP = New Environmental Paradigm (Dunlap et al., 2000).

Although the AC Social Consequences category (altruistic consequences) was lower in T2 compared to T1, the drop was not significant. Some of the increases were also very small (for example AC Ego). Overall, comparing the means and standard deviations of the seven measures before and after the intervention reveals the means in T2 were statistically higher than those in T1, except in the AC Social Consequences category, thus endorsing the finding above. The standard deviation values in T1 and T2 were statistically similar (Table 7.8).

Measures	Time	Mean	Std dev
EC egoistic	T1	5.54	1.46
	T2	5.73	1.34
EC altruistic	T1	6.09	1.10
	T2	6.17	1.02
EC biospheric	T1	6.34	0.88
	T2	6.40	0.82
AC egoistic	T1	5.95	0.86
	T2	5.98	0.87
AC social	T1	6.18	0.75
	T2	6.12	0.86
AC biospheric	T1	5.65	1.03
	T2	5.77	1.02
NEP	T1	5.16	0.71
	T2	5.31	0.74

Table 7.8 Before and after Mean and Standard deviation values in the seven measures.
N = 125.

Ranking of T1 scores was similar to T2 (Table 7.9). There were positive correlations in all paired samples, indicating that higher scores in T1 were associated with higher scores in T2. This was important for the paired-sample t-test because large and positive correlations (above 0.00) imply less standard error in testing the hypothesis that individuals' environmental values increased in T2 compared to T1. Statistically significant 2-tailed value would have a less than 0.05 demarcation.

	Measure pairs	Paired-samples Correlation	Standard Error	Paired differences		Sig. (2-tailed)
				Mean	Standard Deviation	
Pair 1	T2-EC egoistic & T1-EC egoistic	0.679	0.064	0.180	1.126	0.076
Pair 2	T2-EC altruistic & T1-EC altruistic	0.596	0.084	0.085	1.010	0.347
Pair 3	T2-EC biospheric & T1-EC biospheric	0.634	0.071	0.066	0.734	0.317
Pair 4	T2-AC egoistic & T1-AC egoistic	0.354	0.089	0.032	0.989	0.713
Pair 5	T2-AC social & T1-AC social	0.522	0.078	- 0.065	0.797	0.363
Pair 6	T2-AC biospheric & T1-AC biospheric	0.561	0.071	0.120	0.962	0.163
Pair 7	T2-NEP & T1-NEP	0.708	0.056	0.149	0.560	0.004

Table 7.9 Paired sample correlations analysis, T1 and T2. N = 125.

There was noticeable change in some measures between T1 and T2, particularly in EC egoistic and NEP scale, but not in all measures.

7.6.7.2 Split-plot Analysis of Variance (ANOVA)

Split-plot ANOVA mixed design analysis was used to test the differences between visitor groups before and after the intervention (T1 and T2). The analysis looked at comparisons across groups, particularly those with high sample size to compare change over time. As the EIT Trades group did not answer the post-visit survey they were excluded, together with the Environment Centre group as only 10 of these participants completed the post-visit survey. The three groups in the split-plot analysis were VAD Students, EIT Students, and EIT Staff.

From the main t-test comparison (Tables 7.11 and 7.12), only one statistically significant difference between the pre and post surveys was found, this being the

NEP scale ($p < .05$). In addition, there was a marginally significant change in the egoistic concerns measure ($p = .076$), which includes the egoistic measure in ECs as well as ACs. So the split-plot ANOVAs only concerns these two measures.

7.6.7.3 NEP Scale

Descriptive statistics of the 116 participants (three groups) across T1 and T2 are shown in Table 7.10. In T1, both EIT staff and VAD students had rather high mean scores of ($M = 5.24$ and $M = 5.29$ respectively), although at T2, the EIT staff mean had risen marginally to ($M = 5.28$) and that of the VAD students a bit more ($M = 5.41$). For EIT students, the mean score at T1 was ($M = 4.67$) and this rose to ($M = 4.88$) at T2.

The noticeable improvement in T2 in both VAD and EIT students (compared to EIT staff) could be attributed to the students' relative youth, and their values changing in response to what they are told.

Figure 7.10 supports the observations from Table 7.10 with the plot profiles of T1 and T2 showing the largest rise occurred in the EIT student group followed by the VAD students, while rise in the EIT staff group was marginal.

	Groups	Mean	Std. Deviation	N
T1_NEP	EIT staff	5.24	0.68	24
	EIT students	4.67	0.59	31
	VAD students	5.29	0.63	61
	Total	5.12	0.68	116
T2_NEP	EIT staff	5.28	0.73	24
	EIT students	4.88	0.67	31
	VAD students	5.41	0.68	61
	Total	5.24	0.72	116

Table 7.10 Descriptive Statistics of NEP scale measures.

It was clear that the two student groups, mostly young people, were affected by the visit to LCP. Hence, in terms of attempting to educate the community about

pro-environmental practices and change people's values, directing attention to the young could be profitable.

Figure 7.10 Plot profile, NEP scale measure between T1 and T2.

Egoistic measures. Descriptive statistics of the 116 participants for Egoistic measures across T1 and T2 are given in Table 7.11. The EIT students had a high mean score ($M = 5.82$) in T1, which rose to ($M = 6.23$) in T2. The other two groups, VAD students and EIT staff had means scores of $M = 5.46$ and $M = 5.40$ respectively at T1, but at T2 the former had risen to $M = 5.73$ while the EIT staff mean dropped to $M = 5.18$.

Figure 7.11 supports the observations from Table 7.11 showing plot profiles of the three groups at T1 and T2. The largest rise occurred in the EIT and VAD student groups, while the egoistic position of the EIT staff dropped at T2.

	Groups	Mean	Std. Deviation	N
T1_egoistic	EIT staff	5.40	1.42	24
	EIT students	5.82	1.11	31
	VAD students	5.46	1.59	61
	Total	5.55	1.44	116
T2_egoistic	EIT staff	5.18	1.68	24
	EIT students	6.23	0.66	31
	VAD students	5.73	1.29	61
	Total	5.75	1.30	116

Table 7.11 Descriptive Statistics of egoistic measures.

Figure 7.11 Plot profile, egoistic measure (ECs and ACs) between T1 and T2.

The rise for the students could be attributed to the fact they would be concerned about what is coming, because they are young and looking ahead to the world they will be living in. Interestingly, despite the high means at T1 of the VAD students, they still improved their scores at T2. This is in line with other research conducted on young people's environmental attitudes where it was found this age group possesses overwhelming feelings of environmental concerns, combined

with feelings of frustration, sarcasm, and perception of inability to act (Connell et al., 1999).

On another note, many young people left out the question related to their concern about children because they did not see it as relevant, not having children. This is problematic and could have influenced the results.

7.6.7.4 Sustainable actions data

The group visits to the LCP took place between February and August 2016. The focus was on describing the environmental practices, including overall sustainability, passive design techniques, renewable energy use and energy efficiency, water conservation, waste management, recycling and re-use, as well as sustainable landscaping. The post visit questionnaire repeated the pre-visit one with the addition of section 4, which was designed to find out what the visitors have done or intend *to do after* their visit to the LCP. It included 23 sustainable actions that visitors had to indicate whether they had performed before the visit, as a result of it, or would do in the future. The results were entered and labelled in SPSS according to the *number* of listed *actions* they had performed in a five-point scale (1 = 0 actions; 2 = 1–5 actions, 3 = 6–10 actions, 4 = 11–15 actions, 5 = 16+ actions).

Cronbach's alpha coefficient for assessing the internal consistency of data was calculated to be ($\alpha = 0.86$), considerably higher than the recommended ($\alpha = 0.70$).

A total of 126 participants returned the post-visit survey, out of which 90.4% reported doing at least one of the listed actions before visiting the LCP. The most common pre-visit actions were to turn off room lights while not in use (49.0%), use second-hand furniture at home (41.5%), grow veggies or fruit at home (35.0%), install energy saving lights (34.0%), and install recycled or reused materials or items, and produce compost from kitchen waste (both 29.5%), (Table 7.12).

Sustainable actions	Done <i>before</i> my visit to the LCP (%)	Done <i>because</i> <i>of what I</i> <i>learnt</i> at the LCP (%)	I intend to do this action <i>in</i> <i>the future</i> (%)
Install additional insulation in home	23.5	2.5	27.5
Upgrade windows to double glazing	10.0	1.5	35.0
Utilise natural light indoors better	21.5	9.5	22.0
Install energy saving lights	34.0	7.0	16.5
Turn off room lights while not in use	49.0	1.5	8.5
Switch power company to one that uses renewable resources	11.0	3.0	30.0
Purchase higher energy star appliances	23.0	3.0	27.0
Install solar panels for electricity	2.5	1.5	41.0
Install solar hot water heating	4.5	2.0	37.0
Use water saving washing machine	22.5	0.5	28.0
Install water efficient toilet and/or shower head	13.0	1.0	28.5
Reduce time taken in daily shower	25.5	7.5	14.0
Collect and store roof run-off water	6.0	3.5	31.0
Install water efficient irrigation system	7.0	3.0	29.0
Recycle grey water	2.0	4.5	31.5
Install black water management system	1.0	3.0	27.0
Change landscape plants to native	17.0	7.5	24.5
Produce compost from kitchen waste	29.5	4.5	17.0
Grow veggies or fruit at home	35.0	4.0	18.0
Install recycled or reused materials or items	29.5	4.5	14.0
Use second-hand furniture at home	41.5	2.5	10.0
Use low or no VOC paint	7.0	1.0	27.0
Use formaldehyde-free materials for kitchen work surfaces	11.0	3.0	21.5

Table 7.12 Percentage of participants performing target actions, and their future intention. N = 126.

In comparison, the number of sustainable actions that participants had done *before* visiting the LC was not significantly correlated ($p = 0.411$) with the actions done *as a result of* the visit ($r = -0.074$). This may be partially attributed to the fact that a large proportion of respondents were students with limited finance to invest in sustainable technologies, or because a significant number of them did not own their homes. Another reason could be that the period between the pre-visit and post-visit surveys (3–6 months) was short for taking major sustainable actions such as installing PV panels. However, the number of sustainable actions that participants had done *before* visiting the LC was significantly correlated with *future* intended actions ($P < 0.05$). Although this relationship was not strong ($r = -0.214$), it was significant, indicating a link between how environmentally motivated the participants were and the number of actions they intend to implement in the future.

Engagement in specified sustainable activities *before* the visit by gender and age is explained in Table 7.13. However, the correlation ($p = 0.07$) between gender and sustainable action was not significant ($r = -0.162$). According to the *number of listed actions* on the determined five-point scale, the mean for males ($M = 2.91$, Std dev = 1.10) was slightly higher than females ($M = 2.69$, Std dev = 0.86), indicating that males were slightly more likely to be engaging in the listed activities before the visit than females. This was not in line with findings of other studies where females were found to be more likely to engage in pro-environmental behaviour (Meinhold & Malkus, 2005; Schultz, 2001; Swami et al., 2010; Hunter et al., 2004). With regard to age, there was significant correlation ($p = 0.00$) between age and sustainable action ($r = 0.367$) supported by the data analysis showing that engaging in sustainable activities was higher for age groups 55-65 and 65+ ($M = 3.64$, Std dev = 0.92; and $M = 3.63$, Std dev = 1.40 respectively) compared to age groups 17-25, 25-40, and 40-55 ($M = 2.50$, Std dev = 0.76; $M = 2.50$, Std dev = 0.88; and $M = 2.82$, Std dev = 0.95 respectively). This indicated that middle-aged participants were significantly more likely to be engaging in sustainable activities than other age groups *before* the LCP visit.

7.6.7.5 Post-visit sustainable actions

Referring to Table 7.12, a considerable number of participants ($N = 126$) reported implementing at least one action *as a result of* their visit to the LCP (42.1%). The most common actions were to utilise natural light indoors better (9.5%), reduce time taken in daily shower (7.5%), change landscape plants to natives (7.5%), and install energy saving lights (7.0%). Not surprisingly, actions requiring high cost such as installing solar panels for electricity, or installing solar hot water, were not noted *as a result of* the visit (nor *before*), yet these two actions were the highest rated for something participants intend to do in the *future*, with responses of 41.0% and 37.0% respectively. With regard to recycling grey water and installation of black water management systems, both high cost actions, 4.5% and 3% respectively installed them *as a result of* the visit compared to 2.0% and 1.0% respectively *before* the visit. However, intentions to carry out these actions in the *future* were 31.5% and 27.0% respectively.

		Gender		Age				
		Male N = 47	Female N = 77	17-25 N = 50	25-40 N = 24	40-55 N = 33	55-65 N = 11	65+ N = 8
Activities done <i>before</i> the visit	Mean	2.91	2.69	2.50	2.50	2.82	3.64	3.63
	Std dev	1.10	0.86	0.76	0.88	0.95	0.92	1.40
Activities done <i>as a result of</i> the visit	Mean	1.51	1.49	1.52	1.50	1.55	1.55	1.00
	Std dev	0.71	0.59	0.64	0.65	0.66	0.68	0.00
Activities <i>intended</i> in the future	Mean	3.00	3.14	3.36	3.58	2.91	2.36	2.13
	Std dev	1.26	1.15	1.24	1.21	1.10	0.80	0.83

Table 7.13 Means and Standard Deviation of pre and post LCP visit surveys. Means scale relates to the *number of actions* performed on a five-point scale (1 = unsatisfactory, 2 = satisfactory, 3 = good, 4 = very good, and 5 = excellent).

Engagement in specified sustainable activities post-visit by gender and age is shown in Table 7.13, indicating that correlations with actions *as a result of* the visit ($p = 0.61$, $r = -0.045$) or *intended* actions in the future ($p = 0.17$, $r = 0.120$) were not significant. While the mean value for a sustainable action *as a result of* the visit

was similar for males and females ($M = 1.51$, Std dev = 0.71 and $M = 1.49$, Std dev = 0.59 respectively), the means for male participants' *intended* actions in the future were lower compared to females ($M = 3.00$, Std dev = 1.26 and $M = 3.14$, Std dev = 1.15 respectively). This result is in line with studies by Meinhold & Malkus (2005), Schultz (2001), and Hunter et al. (2004). For age, a significant ($p = 0.000$) and strong correlation was found between future *intended* actions and age ($r = -0.317$), while correlation between age and actions *as a result of* the visit were not significant ($p = 0.250$) and weak ($r = -0.103$). The results also showed that the mean values of actions *as a result of* the visit were low across age groups, but for future *intended* actions the means were relatively higher in age groups 17–25 and 25–40 ($M = 3.36$, Std dev = 1.24 and $M = 3.58$, Std dev = 1.21 respectively) compared to age groups 55–65 and 65+ ($M = 2.36$, Std dev = 0.80 and $M = 2.13$, Std dev = 0.83 respectively).

7.6.8 Conclusions

A pair sample t-test was first run to compare the mean levels of the seven measures pre and post-visit. The comparison was direct and the results showed that there was one statistically significant difference in the levels of NEP scores, as there was an increase post visit. Hence, visiting the LCP and being introduced to what it demonstrated in terms of sustainable methods and practices in building retrofitting positively influenced the environmental values of the three groups in question (VAD students, EIT students, and EIT staff). A marginally significant difference in awareness of 'egoistic concerns' was also found.

A split-plot ANOVA was run to compare the change pre and post-visit for each of the three groups for the NEP scores. Although the overall multivariate analysis was not statistically significant, the Post Hoc test comparison between the groups found that VAD students and EIT staff were similar but different from EIT students. For EIT students, the NEP scores increased more (Figure 7.10). This was a main finding because NEP measure was the only variable that changed over time.

Egoistic concerns showed a marginally significant change. However looking at each group and comparing pre and post-visit results, both student groups, EIT and VAD, showed an increase in egoistic concern awareness, but there was a decrease in the EIT staff group over time. Figure 7.11 illustrates this.

Chapter 8: Comparisons and discussions

“That one dramatic moment ... when everything can change all at once is the tipping point”.

Malcolm Gladwell (The Tipping Point, 2002, p. 9)

This chapter discusses the level of involvement of people who worked on or visited the LCP and whether this had any discernible influence on their environmental values. The aim is to answer the three research questions of why people chose to be involved in a sustainable building, how this involvement related to their environmental behaviour and values, and finally whether this led or would lead to further adoption of sustainable practices (Section 1.3).

Comparisons were made between pairs of types of people involved (Table 8.1), although volunteers and management have been omitted because their numbers were very small. The volunteers (Section 7.4) were 3 builders, 2 technicians, and 1 student and there were 2 managers (Section 7.5).

First group	Second group	Phase	Type of analysis
Student designers	Design group	Pre	Quantitative
Student designers	Sponsors	Pre	Thematic
		Post	Thematic
Student graphic designers	VAD group	Pre	Quantitative
Student designers	Student graphic designers	Pre	Thematic
		Post	Thematic
Male students	Female students	Pre	Quantitative
		Post	Quantitative
Student designers and student graphic designers	Visitors	Pre	Quantitative
		Post	Quantitative

Table 8.1 Paired comparisons between LCP actors.

Visitor group findings have been reported in chapter 7 but here their environmental attitudes and values are compared with those of the student designers and student graphic designers.

8.1 Comparisons

The aim of the comparisons is to look for differences in attitudes and values between those who chose to take part and those who did not, as well as between groups with different levels of involvement with the project.

8.1.1 Student designers and the design group

As mentioned in Section 7.1.2, a survey was conducted with the design student cohort, including those who chose to become involved in the LCP concept design. The 6 participating students (the ‘student designers’) were compared with the 19 non-participating students (the ‘design group’).

The first comparison related to the first section of the survey, environmental concerns (ECs) motives (Schultz, 2001) (Section 3.2.1). In Table 8.2 pre-engagement responses of student designers (SDs) to biospheric, egoistic, and altruistic consequences were compared with those of the design group and with data from Joireman et al. (2000) and Snelgar (2006).

	Joireman et al. ⁽¹⁾		Snelgar ⁽²⁾		Design group ⁽⁵⁾		Student designers ⁽⁶⁾	
	M ⁽³⁾	Std dev ⁽⁴⁾	M	Std dev	M	Std dev	M	Std dev
Biospheric consequences	5.22	0.97	5.62	1.06	4.87	1.26	6.16	0.98
Egoistic consequences	5.48	0.95	5.53	1.24	5.16	1.31	5.83	0.98
Altruistic consequences	5.53	0.93	6.24	0.9	5.75	1.15	5.83	0.41

Table 8.2 Comparisons of Environmental Concerns. ⁽¹⁾ Selected results from Joireman et al. (2000, p. 142). ⁽²⁾ Selected results from Snelgar (2006, p. 94). ⁽³⁾ M= Mean. ⁽⁴⁾ Std dev= Standard Deviation. ⁽⁵⁾ 19 non-participating design students. ⁽⁶⁾ 6 LCP design students.

	Dunlap et al. (¹)	Design group ⁽²⁾	Differ- ence	M ⁽³⁾ , Design group	Std dev ⁽⁴⁾ , Design group	M, Student designers ⁽⁵⁾	Std dev, Student designers
• <i>Ecological limits</i>							
We are approaching the limit of the number of people the earth can support. (AGREE)	67%	53%	-14%	4.79	1.40	4.83	1.72
The earth is like a spaceship with very limited room and resources. (AGREE)	80%	63%	-17%	4.89	1.45	5.50	1.04
• <i>Balance of nature</i>							
When humans interfere with nature it often produces disastrous consequences. (AGREE)	86%	68%	-18%	5.05	1.28	5.50	1.51
The balance of nature is very delicate and easily upset. (AGREE)	84%	79%	-5%	5.58	1.09	5.33	1.22
• <i>Human domination</i>							
Humans have the right to modify the natural environment to suit their needs. (DISAGREE)	64%	79%	15%	2.58	1.23	1.18	0.40
• <i>Ecological catastrophe</i>							
Humans are severely abusing the environment. (AGREE)	89%	100%	11%	5.84	0.98	6.33	0.81
The so-called 'ecological crisis' facing humankind has been greatly exaggerated. (DISAGREE)	75%	58%	-17%	2.68	1.49	1.83	0.98
If things continue on their present course, we will soon experience a major ecological catastrophe. (AGREE)	78%	79%	1%	5.74	1.09	6.50	0.54

Table 8.3 Comparisons of selected NEP Items.

(¹) Washington 1990 residents (Dunlap et al., 2000, p. 438). (²) 19 non-participating design students. (³) M= Mean. (⁴) Std dev= Standard Deviation. (⁵) 6 LCP design students.

Discussion of Table 8.2 occurs after Table 8.3, which compares selected items of the NEP from Dunlap et al. (2000) (Section 3.2.3) for the two groups. Table 8.3 shows the percentage of individuals who agreed or disagreed with particular NEP items for both participating and non-participating design student groups and Washington residents in 1990 (Dunlap et al., 2000).

Table 8.2 shows the mean value scores for the SDs were marginally higher than the non-participating design students and those of Joireman et al. (2000) in all three categories of environmental concerns. The mean value scores were also higher than Snelgar (2006) in biospheric and egoistic concerns. This signifies a higher level of environmental values in the design students (Schultz, 2001), which may help explain their motivation to become involved in the LCP. Table 8.3 supports these findings in most NEP items, but also shows a relatively large number of design group students were unsure or neutral about the effects of global environmental issues, such as the 'ecological crisis', on both community and the environment. The comparatively high standard deviation figures in the survey supports this observation. So, educating the community about sustainability and the global environmental situation may influence the attitudes of individuals in the community and serve as a catalyst to encourage a new way of thinking. The latter is essential in achieving the much needed harmonization between human needs and aspirations, social and cultural patterns, and ecological and resource limits. Tables 8.2 and 8.3 revealed individuals who chose to take part in the design of the LCP held a stronger stance on environmental concerns and had a deeper knowledge of ecological issues. This is important for education as unless sustainability is an integral part of the curriculum it could only attract students who are already motivated to think sustainably.

8.1.2 Student designers and sponsors

8.1.2.1 Pre-engagement

Pre-engagement themes and sub-themes that emerged from the SDs' focus group discussions (Section 7.1.1.3) were compared with those from the sponsors' interviews (Section 7.2.1.3) (Table 8.4)

Common theme summary	Student designers	Sponsors
Support and advance the employment of sustainable practices.	Support for responsible environmental behaviour. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Living sustainably and promoting this. • Valuing tradition. • Living in an ecologically valuable environment. 	Promoting advancement of sustainable materials and techniques. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Mandatory sustainability standards in buildings. • Sustainable materials marketing tools.
Dealing with issues of consumption, technology and affordability.	Sustaining natural capital for future generations. Stopping promulgation of consumerist attitudes in the media.	Exploring the relationship between sustainable choices and affordability.
Different themes	Student designers	Sponsor
Support for responsible citizenship behaviour.	Responsible citizenship behaviour, through applying knowledge and skills in appropriate strategies for environmental action. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Motivation through environmental actions. • Role of the media. 	
Seeking to progress knowledge of environmental practices.		Seeking in-depth knowledge of environmental issues. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Business responds to market demands. • Market has to support sustainable materials.

Table 8.4 Comparisons of themes from student designers and sponsors pre-engagement.

In Table 8.4 both groups emphasised supporting and advancing sustainable practices, but the method of implementation differed. The SDs' approach was driven by strong move for environmental action supported by in-depth knowledge (Section 7.1.1.3), while the sponsors wanted legislation and targeted marketing tools (Section 7.2.1.3). Both groups recognised consumption as key in moving towards sustainability, but the students emphasised stopping excess

consumption while the sponsors wanted to direct consumption towards sustainable products.

The SDs showed leadership in intending to affect the environmental values of others through employing and supporting environmental practices (Lord & Brown, 2001). This differed from the sponsors seeking to progress environmental knowledge as an aid to business, being driven by the economic and social environment in which they operate (Curry, 2011, p.22). As individuals, the sponsors had a personal interest in developing environmental knowledge.

8.1.2.2 Post-engagement

Themes were also compared post-engagement (Table 8.5).

Common themes	Student designers	Sponsors
Having the motivation to advance and support environmental action.	<p>Being motivated to support environmental action.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Further environmental knowledge. • Encourage and support others to take sustainable actions. • Being motivated to pursue environmental initiatives. 	<p>Endeavouring to accomplish more towards sustainability.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Meeting demands for sustainable solutions. • Introducing legislation and subsidies to speed up the process. • Further utilisation of renewable energy sources.
Willingness to enable and support environmental action.	<p>Willingness to enable environmental practice.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • The intent to use resources responsibly. • Tendency to opt for sustainable options, sometimes despite cost. • Seeking knowledge of environmentally harmful practices. 	<p>Motivation to support environmental initiatives.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • An opportunity for in-depth knowledge about sustainable practices. • Having a positive and desirable effect on the community.

Different themes	Student designers	Sponsors
Seeking in-depth knowledge of environmental issues.	<p>Seeking in-depth and ongoing knowledge of environmental issues.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Define sustainable knowledge needs. • New and emerging job opportunities. • Knowledge of conserving living patterns. 	
Discussion of factors that can prompt environmental actions in various groups.		<p>Conscious of factors that can prompt environmental actions.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Public environmental actions can be hindered by cost. • Business decisions can be influenced by market and consumer demands. • Designers are the most influential group in the building process.

Table 8.5 Comparisons of themes from student designers and sponsors post-engagement.

Similar to pre-engagement findings, both groups were motivated to support environmental action, but differed in the method for doing this. The approach of the SDs was to support environmental knowledge and take environmental actions, while that of the sponsors revolved around spreading knowledge about sustainable products and encouraging their use through regulation and subsidies. Both groups were also willing to support environmental action. However, although the SDs felt that sustainable actions should happen even if these were not the cheapest, the financial demands of business would restrict the sponsors' environmental actions.

As a difference, the engagement of the SDs in the LCP created a framework within which they could express altruistic and biospheric values, support sustainability principles, and voice concerns about the well-being of self and

others. This contrasted with the sponsors whose main concern was affordability (Section 7.2.2.2). The SDs demonstrated responsible and self-disciplined attitudes, such as choosing the organic and sustainable options, hence demonstrating willingness to act and awareness of environmental concerns. On the other hand, when discussing the factors that can prompt environmental actions the sponsors distinguished between businesses oriented toward the pursuit of self-interest from those concerned with the welfare of society (Karp, 1996, p.112). They also identified *designers and architects* as having a leading role in promoting environmental practices followed, to a lesser extent, by customers.

From the environmental point of view, the SDs appeared to be more influenced than the sponsors from their involvement with the LCP. This could be attributed to having more time and opportunity to explore, analyse, and think about the various aspects of sustainable building and environmental concerns.

8.1.3 Student graphic designers and the VAD group

As mentioned in Section 7.3.2 a survey was conducted with the graphic design student cohort, including the seven who chose to become involved in the LCP. The 7 participating students (the ‘SGDs’) are here compared with the 25 non-participating students (the ‘VAD group’, which includes visual artists and designers).

Table 8.6 compares pre-engagement responses of the SGDs and VAD group to biospheric, egoistic, and altruistic consequences with data from Joireman et al. (2000) and Snelgar (2006).

	Joireman et al. (¹)		Snelgar (²)		VAD group (³)		SGDs (⁴)	
	M (⁵)	Std dev (⁶)	M	Std dev	M	Std dev	M	Std dev
Biospheric consequences	5.22	0.97	5.62	1.06	6.22	0.94	6.85	0.37
Egoistic consequences	5.48	0.95	5.53	1.24	5.05	1.66	6.42	0.78
Altruistic consequences	5.53	0.93	6.24	0.9	6.00	0.90	6.71	0.75

Table 8.6 Comparisons of Environmental Concerns.

(¹) Selected results from Joireman et al. (2000, p. 142). (²) Selected results from Snelgar (2006, p. 94). (³) 25 strong VAD group. (⁴) 7 student graphic designers. (⁵) M= Mean. (⁶) Std dev= Standard Deviation.

Table 8.6 shows students who chose to be involved in the LCP graphic design had scores closer to the maximum 7 in all three EC measures compared to the VAD group, Joireman et al. (2000), and Snelgar (2006). This indicates a high degree of enthusiasm about the environment, understanding, and awareness of the effects of global environmental issues and concern about their effects on communities and the environment. Having only one high standard deviation figure in the survey supports this observation. The mean values for the graphic design students were marginally higher than the LCP concept design group in all three categories of environmental concerns (see Table 8.2). This explains their motivation to take part.

8.1.4 Student designers and graphic designers

8.1.4.1 Pre-engagement

Comparison of pre-engagement themes from the focus group discussions of the SDs (Section 7.1.1.3) and SGDs (Section 7.3.1.3) is found in Table 8.7.

Common themes	Student designers	Student graphic designers
The need to support environmental behaviour and actions.	<p>Support for responsible environmental behaviour.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Living sustainably and promoting this. • Valuing tradition. • Living in an ecologically valuable environment. 	<p>The need for environmental action.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Promoting community-based sustainability projects. • Preserving wild life and natural habitat. • Enhancing public environmental knowledge.
Concerns about the future of the planet.	<p>Sustaining natural capital for future generations.</p> <p>Stopping promulgation of consumerist attitudes in the media.</p>	<p>Concerns about the future due to human actions.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Concerns about welfare of humans and animals. • Conserving natural systems. • Dealing with waste.
Different themes	Student designers	Student graphic designers
Support for responsible citizenship behaviour	<p>Responsible citizenship behaviour, through applying knowledge and skills in appropriate strategies for environmental action.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Motivation through environmental actions. • Role of the media. 	
The need for environmental awareness.		<p>Promoting environmental awareness.</p> <p><i>Sub-themes:</i></p> <ul style="list-style-type: none"> • Promoting environmental education. • Observing green ethics. • Learning from traditional methods.

Table 8.7 Comparisons of themes from student designers and student graphic designers pre-engagement.

Pre-engagement in the LCP, students in both groups shared an overall level of enthusiasm towards the sustainable building project that can be described as assertive and active. Both also demonstrated agreeable and cooperative traits and

were generally sympathetic to the project objectives. Qualitative evidence showed both student groups were strongly supportive of responsible environmental behaviour and actions, with the focus of the SDs more on the *personal* level of pro-environmental behaviour and sustainable living, while the SGDs included *others* by focusing on issues such as sustainable behaviour in the community, public environmental knowledge, and natural capital matters. Both groups were also concerned about the future of the planet, however it was observed that the concerns and knowledge of many design students were *basic and generic* while those of the majority of SGDs were related to *specific issues* such as health, animal welfare, and waste management.

As a way of motivating and supporting responsible citizenship behaviour, the SDs believed in environmental actions, such as inspiring their children and relations to live healthily, and they acknowledged the role of the media in promoting sustainable values (Section 7.1.1.4), while the SGDs had confidence in promoting environmental education in schools, observing green ethics (especially towards animals), and learning from traditional methods (Section 7.3.1.4).

The SGDs may have had different attitudes because when they became involved with the LCP the building activities were underway and the students could see it taking shape as a physical reality. This reality may have reinforced their motivation to take part, compared to the SDs who started ‘from scratch’ and had to imagine what the building might be like.

8.1.4.2 Post-engagement

Post-engagement themes for these two student groups are compared in Table 8.8.

Common themes	Student designers	Student graphic designers
Having the motivation to advance and support environmental action.	Being motivated to support environmental action. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Further environmental knowledge. • Encourage and support others to take sustainable actions. • Being motivated to pursue environmental initiatives. 	Motivate others to act sustainably. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Intent to educate the community ecologically. • Influencing sustainable action. • Aware of the role of media in community education.
Willingness to enable environmental action.	Willingness to enable environmental practice. <i>Sub-themes:</i> <ul style="list-style-type: none"> • The intent to use resources responsibly. • Tendency to opt for sustainable options, sometimes despite cost. • Seeking knowledge of environmentally harmful practices. 	Has the intent to act sustainably. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Demonstrate in-depth environmental knowledge. • Prepared to act sustainably. • Supporting the connections between culture and ecology.
Different themes	Student designers	Student graphic designers
Seeking in-depth knowledge of environmental issues.	Seeking in-depth and ongoing knowledge of environmental issues. <i>Sub-themes:</i> <ul style="list-style-type: none"> • Define sustainable knowledge needs. • New and emerging job opportunities. • Knowledge of conserving living patterns. 	

Table 8.8 Comparisons of themes from student designers and student graphic designers' post-engagement.

After working on the LCP, change was observed in the environmental values of both SDs and SGDs.

Both groups demonstrated high levels of organisation and responsibility in carrying out the requirements of both briefs. The students were emotionally attached to the project and tackled the project work with confidence. The two

groups were also open to new experiences, reflected on the topics discussed in the studio, and were creative in their design proposals. Outside the studio, both groups were motivated to advance and support environmental action in their community. The SDs were particularly keen on educating others and furthering their environmental knowledge about healthy and organic diets and encouraging those around them to make pro-environmental decisions (Section 7.1.3.4). The SGDs were also inspired to influence others and the wider community to adopt responsible and sustainable living practices. They considered environmental education paramount in advancing sustainable values, either through schools or via the media (Section 7.3.3.4), hence demonstrating environmental activism attitudes.

At a personal level, change was also observed in both groups regarding willingness to enable environmental action. The SDs highlighted the importance of living sustainably, using natural resources responsibly, and opting for sustainable choices despite the cost (Section 7.1.3.4). The SGDs shared these values and extended them to the level of intention to act in making personal investments in ecological issues and the environment (Section 7.3.3.4)

The SDs emphasised the significance of acquiring in-depth knowledge of ecology and sustainability concerning energy and resources, organic and healthy living, and possible new job opportunities related to sustainability (Section 7.1.3.3). The SGDs also demonstrated a deep passion for sustainability going over and above what was required in the LCP branding brief, by producing additional outcomes such as a Facebook page and an Otatara site documentary (Section 7.3.3.4).

Briefly, the qualitative evidence showed SGDs were less self-centred and more holistic, and were thinking about the *big picture*. They also had a clear focus on individual issues, such as showing concerns about the use of products from deforested land. They were very passionate about animal rights, and having healthy choices for everybody. They were concerned about the over use of

energy, and had a feeling of anxiety about the future and well-being of upcoming generations.

8.1.5 Male and female students

This section explores gender differences in both SD and student SGD groups.

	Student designers (SDs)			Student graphic designers (SGDs)			Combined student groups		
	Design Group (N)	SD (N)	Ratio	VAD Group (N)	SGD (N)	Ratio	Combined groups (N)	Combined designers (N)	Ratio
Male	5	0	0%	7	2	29%	12	2	17%
Female	14	6	43%	18	5	28%	32	11	34%
Total	19	6		25	7		44	13	

Table 8.9 Student participation in the LCP by gender.

Table 8.9 splits participants in the LCP by gender. From the group of 19 design students 0 male and 6 female students (43% of all female students) took part in the LCP, while from the 25 strong VAD group 2 male (29% of all male students) and 5 female (28% of all female students) participated. For the combined student group (44 students), total participation in the LCP was 2 male (17% of all male students) and 11 female (34% of all female students), suggesting females are more likely to participate in sustainable activities than males, a finding supported by other studies (Meinhold & Malkus, 2005; Swami et al., 2010; Schultz, 2001; Hunter et al., 2004).

In relation to focus group discussions with SDs (Sections 7.1.3.3) and SGDs (Section 7.3.3.3), female students were found to be actively engaged in private and household related pro-environmental behaviour such as respect for sustainable values at home and recycling, compared to male students. This is in line with findings from Hunter et al. (2004, p. 677). Discussions also suggested female students strongly believed in their ability to succeed in promoting and influencing environmental values in family members and friends, a conclusion supported by Meinhold and Malkus (2005, pp. 527, 528).

8.1.6 Combined student designer group and visitor group

The aim here is to compare the results from the pool of students involved in the LCP (concept design and graphic design) with those of visitors to the project, pre and post-engagement.

8.1.6.1 Pre-engagement

Table 8.10 compares means and standard deviations from the surveys for the seven measures in Table 7.8.

Measures	Combined student group N = 13		LCP visitors N = 196		Difference in M values
	M	Std dev	M	Std dev	
EC egoistic consequences	6.15	0.89	5.58	1.44	10.2%
EC altruistic consequences	6.30	0.75	5.98	1.37	5.3%
EC biospheric consequences	6.53	0.77	6.22	1.07	4.9%
AC egoistic	6.46	0.66	5.95	0.86	8.5%
AC social	6.57	0.65	6.18	0.75	6.3%
AC biospheric	5.69	1.10	5.65	1.03	0.7%
NEP	5.61	0.50	5.16	0.71	8.7%

Table 8.10 Mean and Std dev values for the seven measures for combined LCP student group and visitors before engagement.

Table 8.10 show the mean values of the student group were marginally higher than those of the visitor group, especially regarding concerns for other people (altruistic and social, $M = 6.30$ and $M = 6.57$ respectively compared to $M = 5.98$ and $M = 6.18$ respectively) and concerns for the planet and its organisms (biospheric, $M = 6.53$ compared to $M = 6.22$).

The difference in mean values for the combined student group was relatively higher in egoistic measures (both ECs and ACs; $M = 6.15$ and $M = 6.45$ respectively) compared to the visitors ($M = 5.58$ and $M = 5.95$ respectively) indicating higher environmental concern for self, lifestyle, health, and future, as

well as awareness of the effects of environmental issues (Schultz, 2001). The higher mean values for NEP ($M = 5.61$ compared to $M = 5.16$) supports these observations in the way individuals perceive themselves and their sense of connection with nature (Dunlap & van Liere, 1978).

The higher standard deviations in the visitor group indicate a large number of visitors are unsure or ‘on the fence’ regarding the effects of global ecological issues on the community and the environment.

8.1.6.2 Post-engagement

Subsequent to designing and visiting the LCP, both groups were given the same post-engagement survey (Sections 3.2 and 7.6.2). Table 8.11 compares means and standard deviations for the seven measures in Table 7.8.

Measures	Combined student group N = 13		LCP visitors N = 125		Difference in M values
	M	Std dev	M	Std dev	
EC egoistic consequences	6.07	1.18	5.73	1.34	5.9%
EC altruistic consequences	6.61	0.52	6.17	1.02	7.1%
EC biospheric consequences	6.46	0.77	6.40	0.82	0.9%
AC egoistic	6.08	1.11	5.98	0.87	1.6%
AC social	6.64	0.50	6.12	0.86	8.4%
AC biospheric	6.30	0.85	5.77	1.02	9.1%
NEP	5.76	0.59	5.31	0.74	8.4%

Table 8.11 Mean and Std dev values for the seven measures for combined LCP student group and visitors after engagement.

The results in Table 8.11 follow a similar pattern to those of Table 8.10. The mean values for the student group were marginally higher than those of the visitor group in all categories. However, it was observed that the difference in egoistic mean values (in both ECs and ACs) between the two groups was larger before engagement (10.2% and 8.5% respectively) than after engagement (5.9% and

1.6% respectively) in favour of the students, suggesting that the LCP engagement had more influence on visitors in terms of environmental concerns and awareness of consequences about self, health, lifestyle, and future compared to students.

A similar observation was made regarding the EC scores in biospheric mean values where the difference before engagement between the two groups was 4.9% and became 0.9% after engagement. Having said that, the difference in AC scores in favour of the student group in biospheric measures increased from 0.7% before engagement to 9.1% after it. This suggests that taking part in the design of the LCP may have influenced the values of perceived biospheric consequences (such as climate change and its potential effects on wildlife, living species, and environmental degradation) in the SDs more than the visitors.

Observation of the relatively higher difference in the means value of the NEP scale after involvement is also significant in both groups ($M = 5.76$ for students and $M = 5.31$ for visitors) with similar percentage differences in mean values. This supports earlier findings from the visitors' survey in Table 7.10.

8.2 Tipping point

The findings from analysing the values and attitudes of people choosing to become engaged in the LCP suggest *action* is important. Taking part seems to be a significant moment for behaviour change, as it creates a medium for learning new behaviour and abandoning the old. In this project action only increased as the project gained momentum. When the building was almost half finished some people volunteered to be involved with it. The acceptance *tipping point* or threshold came when there was sufficient physical reality that people could see becoming involved would produce something tangible. This suggests that moving towards sustainability stems from the initial involvement of a few highly motivated individuals but when there is sufficient physical reality and reduced psychological distance, more people become involved.

Because this issue emerged in the LCP, it is important to step back and look at some of the theories behind the tipping point and argue for this occurring in the LCP.

8.2.1 Theoretical models

The theoretical perspectives of the threshold model, the tipping point, and psychological distance can help in understanding why people engaged in creating a demonstration sustainable building.

Granovetter's (1978) seminal work established a model for collective behaviour to explain the way people change through setting up a pattern for individual decision making within a group. His idea was that each individual has a *threshold* such that the decision to act is determined only if a proportion of others have already acted. The balance of costs and benefits determines the individual's preferences and eventual decision-making. Based on simple principles of aggregation, the model included a frequency distribution of thresholds allowing the calculation of an equilibrium number of individuals by which a specific decision may be made (Figure 8.1). The analysis was intended for application to any appropriate binary decision, and assumed that thresholds were distributed uniformly (45° line). In Figure 8.1, the point of intersection between the S-curve, representing a certain cumulative distribution function, and the 45° line of uniform distribution is the equilibrium point from a frequency distribution of thresholds in a process occurring over time.

Granovetter maintained that such threshold models would be useful in small-group settings as well as those with large numbers of individuals, yet stressed that thresholds, being behavioural dispositions, are difficult to measure with confidence before the behaviour actually occurs. He also observed that a very small change in the distribution of preferences could generate a large difference in the outcome. Chiang (2007) supported this argument using an extension of Granovetter's threshold model to investigate *bandwagon* dynamics in social networks. He found that participation levels increase when network structures

depart from pure homophily leading to further participation. Chiang affirmed that this principle is consistent with insights from other empirical studies.

Figure 8.1 Graphic demonstration of the uniform distribution of thresholds and the equilibrium point of their distribution (Adapted from Granovetter 1978).

Related to the threshold model, Gladwell (2002) later defined a *tipping point* as the moment of the emergence and spread of an idea or a change in social behaviour, thereby crossing a critical threshold and leading to its spread. Traditionally, the term has often been used in social rather than environmental sciences in order to define a phenomenon or rare event that becomes more common (Nuttall, 2012). In particular, Gladwell stressed that changes that mark everyday life phenomena and social behaviour may start with one precisely targeted push, just like an epidemic; hence social changes occur suddenly rather than slowly as little causes can have big effects (Gladwell, 2002). For a tipping point to occur, he classified three rules based on a way of understanding epidemics. First is the rule of the few, in theory the 80/20 rule that a minority of people accounts for the majority of the phenomenon. Second is the stickiness factor, which addresses basic issues of successful communication and how to attract attention and make messages

memorable and compelling. Third is the power of context, stressing the fact that people are sensitive to particular, topical issues caused by time and place.

Another related theoretical model for the present argument is Trope and Liberman's (2010) Construal Level Theory (CLT) that examines psychologically distant objects or events. According to the theory, there are four main dimensions of *psychological distance* when people mentally represent objects/events not directly experienced in reality. These are temporal (time), spatial (physical space), social (interpersonal), and hypothetical (imagining that an event is likely or unlikely) (Trope & Liberman, 2010; Liberman et al., 2007). The general idea is that the more distant an object/event is from the individual, the more *abstract* it appears, while the closer it is, the more *concretely* it will be perceived. Thus, more remote entities, such as places, people, objects and events, are represented more abstractly than proximal ones. CLT also considers psychological distance to be a subjective experience of immediate surroundings, proposing that the various distance dimensions be anchored on a single reference point representing direct experience of the present. In a study of proximity to the coast in New Zealand and its link to climate change beliefs (and inherent sea-level rise), Milfont et al. (2014) found that lower psychological distance (indexed by living nearer to the coast) was generally associated with higher levels of concern for climate change. Another related study observed that considering adaptation options to sea level rise, thus making the issue psychologically closer, influenced people's pro-environmental intentions (Evans et al., 2014).

The installation of wind turbines in the Hockerton Housing Project (Section 3.4.4) provides a good illustration of how psychological distance influences environmental perceptions. Stimulated by the aim of being self-sufficient in food, water, and energy, a group of people was involved in the project from the beginning and was motivated to invest their own money in a low-environmental impact project. During the process of design and building, the group was able to withstand problems that arose on a number of occasions, including the installation of two small scale wind turbines (Vale & Vale, 2013, p.262). At the beginning, the reality of installing the turbines was temporally distant and of

uncertain results. After four years of trying to convince people the turbines would not have a negative effect, they were eventually installed. Later, after the psychological distance was decreased and people could see the minimal impact of the wind turbines, the other residents in the village of Hockerton decided to purchase and install a second-hand wind turbine in order to help lower carbon emissions in the local community, thus producing more electricity than the village consumes. This example illustrates psychological distance (temporally distant and uncertain benefits of the wind turbines) as well as the threshold/tipping point of collective acceptance once uncertainty was reduced. This example also shows how certain values held in the community can inspire action, in the case of Hockerton by motivating others to initiate further projects in the same village to the benefit of all. As discussed below, similar processes seem to have emerged in the LCP.

8.2.2 The LCP tipping point

This section examines findings from analysis of the various focus groups and interviews, with particular emphasis on the question: *What was your motivation for taking part in this project?* The focus is on the involvement of project designers, sponsors, project graphic designers, volunteers, and management.

The analysis shows that the motivations of various parties differ according to the balance between costs and benefits, which in turn determines an individual's decision making, a finding supported by Granovetter's (1978) threshold model. For SDs, the main benefit was to fulfil their passion for nature and ecology, especially when their interests were focused on a real project, which made the knowledge learned more relevant (Section 7.1.3.4). SGD's had similar motivation (Section 7.3.3.4). On the other hand, for the sponsors, business benefits and having a commercial edge over competitors was the main motivation for taking part (Section 7.2.1.4). As mentioned before, once the first two sponsors were on board, it was easier to persuade others to participate, again suggesting a tipping point in sponsorship.

For the volunteers (builders, VAD technicians, and project documentary makers) the fact that they decided to take part sometimes without being asked was significant (Section 7.4.4). That attitude coincided with the LCP works being sufficiently complete for the project to seem *real*, which made the benefits of engaging seem worthwhile from the view of feeling good. A similar observation can be made with regard to management staff (Section 7.5.2). It is worth mentioning that other EIT staff members, not included in this study, also expressed their willingness to take part at this later stage in the project.

According to Gladwell (2002, p.29), there are three rules for a tipping point to occur and a message to cross a threshold. Applying them to this study, the *first rule* (the law of the few, where the success of any kind of initiative is dependent on the involvement of people with particular set of leadership and social skills) is shown by the author, an EIT staff member, who took a hands-on approach, and gave a lot of time and energy outside work hours to the project. In doing so he was leading from the front. As well, there was a team of 6 out of a total 19 design students who were sufficiently motivated to take part in the project design, and also a team of 7 out of a total 25 VAD students who were inspired to take part in the graphic design and branding of the LCP. The same observation can be made with regard to the contribution of VAD technical staff and the first two sponsors. The *second rule* (the stickiness factor) highlighted the manner in which information about the project and its objectives was packaged. Under the right circumstances it became irresistible for sponsors and later for EIT management to respond positively to taking part because 'others were doing so'. The *third rule* (the power of context, where the ideas embodied in the project were sensitive to the conditions and circumstances of the time and place) perhaps emerges as a testimony to the power of one aspect of context, in this case sustainability, which was critical for many in the community. Another contextual aspect was the cultural, historic, and spiritual association of the site for the local Māori communities (see Section 1.4.1). These three rules are identified in the data in Table 8.12. Moreover, because the project was part of an educational institution, it gave it status as a place related to teaching values. This was a main threshold (or motivating factor) for almost all participants in the project.

	Design Students	Sponsors	Project volunteers Students	Staff	Management
Law of the few	✓	✓		✓	
Stickiness factor		✓			✓
Power of context	✓	✓	✓	✓	✓

Table 8.12 Gladwell's three rules for achieving a tipping point as applied to the LCP.

As the project gained momentum, it became more acceptable for people to volunteer to become involved. From the analysis, the acceptance threshold or tipping point came when there was enough physical reality emerging from the building work and people could see that becoming involved would produce something tangible. Therefore, it seems that the threshold emerged when the reality of the building became psychologically close (Trope & Liberman, 2010).

Figure 8.2 The tipping point for the LCP.

*The Environment Centre is a local group who want to rent the finished building for meetings.

At first, the reality of the refurbished building was temporally distant and uncertain, resulting in passivity or inaction. The refurbishment process then made it visually present, certain, and temporally near to the people concerned, reducing psychological distance and promoting active action (Figure 8.2). This is in line with recent research showing that motivation to act pro-environmentally increases when psychological distance decreases (Milfont et al., 2014).

8.2.3 Conclusions

Findings from this analysis suggest that motivation to engage in a demonstration sustainable building project increases after a threshold/tipping point of enough of the building becoming reality is reached, which coincides with a perceived reduction of psychological distance. In this case, as the project gained momentum and become psychologically closer (i.e., physically present) it became more acceptable for people to be involved. A similar process was also observed in the introduction of wind turbines in the Hockerton Housing Project in the UK, as noted above.

In conclusion, in order to move people to become more sustainable, it is essential for them to be doing something that others can see in relation to issues of sustainability, especially sustainable buildings. When people witness the physical results of that work, they are more prepared to join in, and this seems to spill over to other parties. Therefore *action* is essential where behaviour change is involved. This is important for moving to a sustainable built environment. We need sufficient sustainable buildings to reduce psychological distance, so that people want to live and work in them and will start to demand them.

Chapter 9: Summary and Conclusions

“A story has no beginning or end: arbitrarily one chooses that moment of experience from which to look back or from which to look ahead.”

Graham Greene (The End of the Affair, 2004)

The main aim of this research has been to deepen the understanding of issues that people face in relation to sustainable building practices, the living environment, and resource management (see Section 1.2). The research problem has been addressed through collecting and analysing data from a number of focus groups, interviews, and surveys involving the various actors who took part in the LCP (see Chapters 7 and 8). The briefing criteria for the LC demonstration sustainable building project have also been explored as part of a teaching discourse involving the student designer actors (see Chapter 6). A framework for a multiple-case study, presented in Figure 5.4, outlines the basis for conducting the empirical studies.

9.1 Answering research questions and subsidiary conclusions

Addressing the knowledge gap identified in Section 5.1, this discussion will be focused on answering the three research questions posed in Chapter 1.

9.1.1 Engaging in a sustainable project

The first research question was: Why do people choose to engage with the various stages of a demonstration project for sustainable building?

This research used the process of designing and retrofitting a sustainable project to investigate the values held by those who did or did not elect to become involved in the process. As might be expected people chose to be involved with the LCP for various reasons. However, the analysis showed that those who became involved tended to have at least a heightened awareness of sustainability issues and for some values and attitudes that reflected this interest. The latter included a willingness to adopt sustainable practices, appreciate ecological and organic living methods, and support the responsible use of natural resources. The project's context of converting a near derelict existing building to being a sustainable one was also important in inspiring individuals to do something tangible and beneficial for both sustainability and the local community. In general, those who chose to engage with the project expressed a passion for nature, culture, and ecology, as well as having the intention to act. This supports Hines et al.'s model of responsible environmental behaviour (Figure 3.5). Accordingly, the following outcomes as related to the various groups emerged.

For both groups of design student actors, SDs and SGDs, the pre-engagement studies showed students who chose to take part in the LCP held stronger views on environmental issues and had a deeper knowledge of ecological matters than those who did not. The analysis (Sections 7.1.1 and 7.3.1) offered qualitative evidence for basic understanding of self, others, and biospheric issues in relation to the environmental, social, and economic platforms. The students had the knowledge, motivation, and intention to act sustainably, and some also tried to influence others to behave sustainably and be ecologically responsible. This offered an explanation of the reasons why these students out of the whole cohort decided to be involved in the project. The engagement of SDs and SGDs with the LCP over a relatively longer period of time, compared to other actors such as Trades students, seemed to help strengthen their passion for pro-environmental actions and develop a sense of empowerment in terms of having greater knowledge about issues and greater intent for environmental action (Hungerford & Volk, 1990). Furthermore, the dynamics of engaging the students in a real sustainable activity, such as designing the LC, was important in terms of how they

were helped to come to grips with all the information available about sustainable buildings. The focus of dealing with the building meant they had to seek out relevant information that could be applied to the project (see Section 6.5). There are far too many sustainable design projects that are vague and imaginary but, the moment the students were made aware that they were the designers of the project, they owned it. The lecturer/author from that point on was a supplier of information and the students led the project.

For sponsors, the main motivations for taking part were business benefits and having a commercial edge over competitors. Interviews with the sponsors stressed the need for a *balance* between sustainable solutions and affordability, but also emphasised the significance of offering the public tangible solutions for building sustainability they could visit. For the sponsors affordability is the main concern in the promotion of sustainable materials and techniques, as these are seen as *different* from mainstream products. This is curious since most of the materials used in the LCP were, perhaps with the exception of the PV panels and waste treatment system that is yet to be installed, conventional materials. It is the way materials are assembled that makes a sustainable building, not the materials.

After visiting the LCP, the attitude of EIT management and executives towards the project changed compared to their original hands-off stance. As the project progressed and became physically tangible the enthusiasm of those who came in contact with it became noticeable. At this stage people volunteered their help motivated by their passion for nature and ecology, and realising after witnessing the progress of the building works that they could make a positive contribution. Generally speaking, individuals seem to respond and become environmentally motivated after visiting the LCP, demonstrating that people are sensitive to their built environment.

With regard to the way environmental concerns motivate environmental action, it seemed that for the SD and SGD groups, biospheric as well as altruistic concerns could form a path of entry into environmental action, in this case

choosing to be involved in the LCP (see Sections 8.1.1 and 8.1.3). In part this finding may be explained by the diversity of issues that both groups of students covered. Primarily students were concerned with protecting the environmental quality and liveability of their communities. The breadth of issues from concerns about the future to supporting sustainable living standards may reflect the need to broaden environmental actions to encompass a wide range of members of the community (see Sections 7.1.1 and 7.3.1). It could be these student groups viewed involvement with the LCP as a means of doing this.

9.1.2 Effect on values

The second research question was: How does this engagement relate to the individual's environmental behaviour and values?

As mentioned in Chapter 1, this research has been focused on raising people's awareness of environmental limits and getting them to realise the effects of the stress placed on the global environment (Section 1.1.1). This is communicated through exposure to ecological building techniques and practices using a demonstration building project that would show the public possible ways of living and building sustainably. Overall those who became deeply involved with the project were more likely to hold stronger sustainability values than those who just visited. However, even visiting the LC demonstration building had an effect.

In general, participants were keen to acquire in-depth knowledge about environmental matters, and so gain ownership of the issue. Also, following their engagement in the LCP, many participants seemed to have the desire to be involved in sustainable action and the drive to support and educate others to act sustainably. For many, their intent to try to influence other individuals to adopt responsible, healthy, sustainable, and ecological living practices was clear evidence of empowerment and readiness for environmental action. This is endorsed by Hungerford and Volk's model of environmental behaviour (Figure 3.6).

The student designers seem to have been affected by their experience of and knowledge gained through the LCP design by being quick in taking steps towards acquiring and adopting environmental values with passion. The students took ownership of the project and worked enthusiastically with developing awareness of sustainable building methods and concern for ecological living practices. Post engagement interviews demonstrated an evolving responsible environmental behaviour in valuing ecological and organic living practices, stressing the sensible use of energy and other natural resources, and often opting for sustainable choices despite the cost (see Section 7.1.3). Individually, students also developed skills for investigating and evaluating environmental options, particularly living and diet options, and using new media platforms for communication.

Sponsors were aware that sustainable building is not currently *mainstream* in New Zealand, although acknowledging it is now becoming more accepted by the public. Sponsors saw their involvement in the LCP as an opportunity to learn more about sustainable building methods in support of their desire to lead the market in supplying materials and supporting sustainable construction (see Section 7.2.2). They still saw affordability as a problem, but thought this could be overcome by the ecological passion of clients and architects.

Following their engagement in the LCP, student graphic designers expressed support for environmental actions by signalling personal intentions to adopt some of the LC sustainable practices in the future and also by calling for wider utilisation of the LCP retrofit practices. Realising the significance of having an understanding of sustainability issues for the well-being of future generations, the group felt strongly that environmental education in schools would be an effective way to promote responsible citizenship behaviour and called for this to be in senior school curriculum. During their involvement in the LCP, the student graphic designers developed a sense of ownership through passionately engaging in the branding and graphic design of all promotion materials for the LCP. In doing this they displayed concern for the future and a passion for preserving

natural resources, living organisms, and minimising consumption, hence developing a strong pro-ecology stance.

For visitors, surveys comparing results before and after visit showed improved scores in six of the seven survey measures (Section 7.6.7 and Figure 7.9), with improvements in EC egoistic measure and NEP scale most noticeable, especially in the case of VAD student and EIT student groups (Figures 7.10 and 7.11). This could be because students are more concerned about the effect of a degrading environment on their lifestyle, health, and future given their relative young age compared to other visitor groups.

When it comes to change in values and attitudes the research found a shift in these seemed to come at a critical or *tipping point*. This was when a virtually derelict log cabin, with its historic and cultural significance, was clearly becoming a demonstration facility for sustainability. This sudden change was at the centre of the tipping point, where some people's attitudes *changed* because enough people had been engaged in making the LC a sustainable building for the idea to be credible (see Section 8.2). It seems as the LCP gained momentum, it became more acceptable for people to be involved with it. This important finding suggests *action* of particular individuals who lead from the front can create a means for others to learn new behaviour and abandon the old. When the building was almost half finished people began to volunteer to become involved with it. The acceptance tipping point or threshold came when there was enough physical reality that people could see becoming involved would produce something tangible and valuable. The results so far suggest that changing to sustainability stems from the initial involvement of a few highly motivated individuals but when there was sufficient physical reality and reduced psychological distance, more people become involved. According to Gladwell (2002, p.259), the world may seem like a stationary place, but "with the slightest push, in just the right place, it can be tipped."

9.1.3 Undertaking sustainable practices

The third research question was: Will this engagement lead to further adoption of sustainable practices?

The research project endeavoured to inspire sustainable behaviour through transmission of the experiences of engaging in a demonstration sustainable project (Section 1.2.3). This is done *internally* for the group involved in its design, building and retrofitting, as well as *externally* for the parties and communities outside this group but that came into contact with it (Section 1.1.2). So, the short answer to this question is ‘yes’ but to a degree. Because many actors in this research were students they had both limited opportunity and money for some of the potential sustainable building practices. However, the students were keen to bring sustainability into other areas of their lives, such as diet and to an extent transport. At a personal level, many actors seem to have been inspired to embrace sustainability and demonstrate leadership and willingness to undertake sustainable action. At a community level, actors were also motivated to influence others and the wider community to adopt responsible and sustainable living practices. With regards to the visitor groups, there was a noticeable change in some measures pre and post-visits, particularly in EC egoistic and NEP scale, but not in all measures (Section 7.6.7.1).

Consequent to their involvement in the design of the LC concept, student designers demonstrated intention to take sustainable actions. Armed with environmental knowledge, the students were motivated to pursue ecologically inspired initiatives, both at a personal level and in empowering others to adopt sustainable actions (see Section 7.1.3).

The sponsors had less contact with the reality of the project and this seems to have affected their taking up of sustainable practices. However, S1 showed a level of environmental commitment by requesting a list of suppliers who deal with sustainable building materials and systems, demonstrating responsible environmental action.

As mentioned before, the student graphic designer group has shown strong passion for sustainability through producing more work for the project than asked for in the course documents. The group also displayed strong intent to act sustainably and a high degree of moral responsibility through trying to influence others to adopt healthy, ecological living patterns. Their particular attention to animal welfare issues is evidence of empowerment and intent to take environmental action.

In comparing these two design student groups, it is important to point out that the student designers were involved at the very beginning before the project works started, while student graphic designers were engaged when the building retrofit works were well underway. Another issue concerns the LCP being an optional part of the curriculum for both student groups. Those who chose the LCP were already motivated to think about sustainability issues and actions. Unless sustainable design, in whatever form, becomes core in the curriculum, it may be that teaching initiatives like the LCP will continue to ‘preach to the converted’. That said, the students who did take part seem to have been empowered to try and convince others to think about the issues and take sustainable actions (Sections 7.1.3 and 7.3.3).

Through comparing the pre and post-visitor surveys it seems there are indications of change as a result of visiting the LCP (Section 7.6.7). However, because of the many possible influences on intent to act it is not possible to state that such intentions are absolutely to do with the project. However, since all the separate visitors have demonstrated similar sorts of signals of intention the LCP appears to have inspired visitors environmental action (see Table 7.12), given 42.1% of those who returned the post-visit survey reported implementing at least one low-cost sustainable action *as a result of* the visit (Section 7.6.7.5). On the other hand, 96% of those who returned that survey reported *intend to do in the future* at least one sustainable action, including high cost investments such as installing solar panels for electricity, or a solar hot water system. Results also showed the mean values

for actions people *intend to do in the future* were higher in age groups 17–25 and 25–40 highlighting young individuals' passion and intention towards sustainable action leading to pro-environmental behaviour (Hines et al., 1986/87).

It is worth noting that subsequent to visiting to the LCP a number of individuals were keen to take part in environmental actions. Five VAD student visitors became involved with Environment Centre Hawke's Bay through giving time and technical experience to keeping the Centre's website, Facebook page, and other social media avenues updated and to improve them. Student SGD1 designed an electronic game aimed at educating children about sustainable practices influenced by the LCP objectives (Section 7.3.3.3). Many offers of help with finishing the LC were received from visitors. Three VAD student visitors separately offered to help with the building works, two EIT staff visitors offered to help with planting around the project, another EIT staff visitor offered to design and make the LCP curtains, and two visitors separately offered to help with the interior painting.

9.1.4 Subsidiary conclusions

In addition to the answers to the three research questions, some subsidiary conclusions were identified in the thesis.

- Concerning ecological ethics, pre-engagement focus group analysis of the involvement of SD and SGD groups offered evidence of the participants' understanding of the social, cultural, economic and environmental platforms of sustainability while demonstrating the knowledge and intention to act sustainably. This emphasised the opinion that green practices are both political issues and issues of personal passion and interest.
- Qualitative evidence showed both SD and SGD groups were strongly supportive of responsible environmental behaviour and actions. However, while the focus of the SDs was more on the *personal* level of environmental behaviour and sustainable living, the SGDs included *others*

by focusing on issues such as sustainable behaviour in the community, public environmental knowledge, and natural capital matters.

- Both student groups were observed to be concerned about the future of the planet, however it was noted that the concerns and knowledge of many in the SD group were *basic and generic* while those of the majority of the SGD group were related to *specific issues* such as health, animal welfare, and waste management.
- In relation to community education, the SGD group felt very strongly about extending environmental education in schools beyond junior levels. They also highlighted the influential role of the media in educating the public about ways of living and behaving sustainably.
- Comparing the results of the pre and post-visit surveys of the three visiting groups of VAD students, EIT students, and EIT staff (Section 7.6.7.1), showed statistically significant difference in the levels of *NEP scores*, as there was an increase post visit. Hence, being in contact with the LCP and its demonstrated sustainable practices positively influenced the three groups in question. A marginally significant difference in awareness of *egoistic concerns* was also found.
- Both SDs and sponsors emphasised supporting and advancing sustainable practices, but the method of implementation differed. While the SD's approach was driven by sound environmental action supported by in-depth knowledge (Section 7.1.1.3), the sponsors wanted legislation and targeted marketing tools (Section 7.2.1.3). Both groups recognized consumption as key in moving towards sustainability, but the SDs emphasised stopping excessive consumption while the sponsors wanted to direct consumption towards sustainable products.
- Both SDs and sponsors identified architects and designers as the probable influential actors in implementing sustainable practices in the building sector followed, to a lesser extent, by consumers.
- In relation to gender, quantitative evidence suggested females are more likely to participate in sustainable activities than males, a finding supported by other studies (Section 8.1.5).

Finally, and in relation to the method, this research has led to a number of other outcomes of possible value;

- The development of a research framework for the study of the relationships between behaviour and sustainability giving consideration to their contents in both architecture and psychology.
- The development of a method for engaging individuals in the design and building of a sustainable project.
- The development of a method for measuring the effects a sustainable project on those who visit it.

9.2 Towards addressing the gap in knowledge

In general, the findings in Section 9.1 seem to support the suggestion that the experience individuals had in engaging in the designing, building, and visiting of the LCP and the opportunity this gave to be introduced to how to build and live sustainably has affected and inspired change in people's values towards sustainability. In turn this has motivated their pro-environmental behaviour, both at home and in the wider community. The LCP made the complex problem of sustainable building a tangible and visible concept for both visitors and those who worked on it. Independently, the demonstrations displayed in the LCP were physically present and represented everyday situations. The important role of architectural research is to examine and convey experiences carried out in practice continuously (Lockton, September 2011). In the case of this research the addition to knowledge was through looking at the potential for *buildings to teach* by displaying *good examples* in order to inspire behavioural change, and then to check to see if change has happened.

Once fully completed, the LCP will provide monitored data as well as remaining a demonstration of sustainable building regarding products and systems and how they are implemented, as well as sustainable living practices. The LCP will provide a venue for supporting and developing the learning of sustainable

methods, including participants from schools and the community, as well as EIT students.

9.3 Comparison of the LCP with demonstration sustainable buildings

The Utah House (Section 3.5.2) found that in spite of the number of actions people performed following the visit, visiting the house was no strong predictor of later involvement in pro-environmental behaviour (Dietz et al., 2009). This is consistent with Hungerford and Volk (1990) confirming linear progression from knowledge to awareness and then to action is not supported. Nevertheless, this research found a shift in people's behaviour occurred at a *threshold* when there was enough physical reality that people could see becoming involved would produce something tangible. It seems it is involvement rather than visiting that is key in behaviour shift.

Results from the Utah house also support LCP findings in terms of gender participation with higher levels of female awareness and passion for environmental issues. Concerning actions as a result of a visit, 63% of people reported implementing at least one of the actions in the Utah House compared to 42.1% in the LCP. This could be attributed to the longer turn around in the post-visit responses of 1–2 years in the Utah House compared to 3 months in the LCP, as well as the fact that the LCP was not fully complete at the time of the visits reported in this thesis.

When it comes to responsible environmental behaviour, this research reflects Hines et al.'s (1986/87) model of environmental behaviour (Section 3.3.1) viewing *intention to act* as a direct determinant of pro-environmental behaviour. Those who chose to take part all exhibited a raised level of pro-environmental behaviour over those who did not (Sections 7.1, 7.2, 7.3, 7.4, and 7.5). On the issue of environmental education and behaviour change, the research outcomes concur with Hungerford and Volk's (1998) conclusions by confirming that issue awareness does *not* lead to behaviour change in the environmental dimension.

Instead the focus needs to be on individuals developing a sense of ownership and empowerment so that they are prompted to become environmentally responsible and active citizens. In this research a number of groups such as student designers, student graphic designers, and volunteers *owned* the project through taking the opportunity to become part of the decision making in changes made to the LC. They also had the motivation, knowledge, and skills to *empower* and influence those around them to adopt sustainable actions (Sections 7.1.3, 7.3.3, and 7.4).

9.4 Limitations of the research

Limitations in this research are discussed in relation to the building and the timing of both the investigations and the building works.

9.4.1 Building issues

One major limitation to the redesign of the LCP was funding the project works, which included raising funds to pay for materials and labour. From the beginning, it was the LCP works had to be sponsored with no cost to the institution (EIT) (Section 6.6 and Section 6.2.1). The author worked hard to convince sponsors to be part of the project. Despite the fact that most materials, systems and equipment needed for the retrofitting were secured through sponsorship, a few items are still pending, such as the water tank.

Shortly after the project works commenced it was realised that sponsorship does not mean giving items and services totally free. Therefore, funds to pay for part of the materials and labour costs needed to be raised. Eventually, the author secured two EIT Research Grants, each to the value of \$4,000. When the project was ‘physically present’ the author’s manager decided to contribute to the building costs out of the School budget, a decision that could be attributed to the tipping point factor (see Section 8.2). The author has put a lot of energy and time into managing the project works, having to coordinate the various working groups, keep the sponsors interested and convince new ones to take part, as well as physically contributing to the building effort. This was done in addition to the demands of a full time job, and this PhD study. This means that the interventions

in making the LC sustainable had to be low key and buildable, often with one or two people on site. However, although a limitation this has the advantage of making sustainable building seem doable for the average handy-person householder.

The Trades' students and tutors were of huge assistance in the LCP's building and electrical works. They also agreed to contribute to the upcoming plumbing works. However, there were problems. From the start, a committee was formed that included the author and three other staff from the Trades to manage and coordinate the building works. However, the first absence of funds and sponsorship, which caused the project building momentum to stall, meant this committee was soon disbanded. The second problem was the Trades' inability to incorporate the LCP into their curriculum, as the nature of the building being a log construction was not common technology in New Zealand. Additionally, some of the works in the LCP were beyond the skills of the Trades' students, especially concrete works.

The timetable for the building works had many delays due to its heavy reliance on volunteers and sponsors. The major delay was at the roof insulation phase where the project works stopped for a few months (see Section 6.8.2). In spite of all endeavours, the LCP works could not be completed in time for the visitor groups (and the completion of the PhD study). The next phase is plumbing works, which EIT has agreed to pay after a senior manager visited the project (tipping point), but even this has been delayed by the Corporate Services at EIT despite the permission to proceed. The following phase will be to install and connect the photovoltaic and solar hot water systems, both sponsored, as well as the wastewater treatment system. This has meant that visitors have not been shown all systems in use, which may have affected their responses to the survey.

9.4.2 Investigation timing issues

Had the LCP been completed and operating, the investigation outcomes would have been more reflective of the influence the LCP had on visitors. This also

applies to sponsors, as responses to the interview questions about the finished building could not be used in the analysis.

On another note, post-engagement investigations could not be undertaken with Trades students who participated in the project, such as the planned focus groups with student builders and electricians (12 and 11 participants respectively) and surveys with 15 student visitors, because these students finished their qualification soon after their involvement in the LCP and left EIT. The fact only 10 out of 23 visitors from Environment centre Hawke's Bay returned the post-visit questionnaire could be a timing issue. Perhaps visitors were disappointed the LCP was not complete, and therefore did not bother to reply. Given this was a group aware of environmental issues a greater response rate was expected.

9.4.3 Timing of building works

As previously mentioned, raising funds was a major issue with the LCP. It might have been better to raise at least some funds prior to approaching the sponsors, possibly through applying for grants. On reflection, when sponsors agreed to support the LCP, they were full of enthusiasm influenced by the author's approach and what the project was about. However, the sponsors expected immediate involvement, and because the works were delayed, for some sponsors by as much as one or two years, interest went 'cold'. This is another example of the difficulty creating a critical mass. Had EIT agreed to commit the \$8000 at the very start of the project it would have been easier both to gain sponsors and keep the building work on schedule.

9.5 Further research

This thesis has contributed to the field of design for behaviour change. In the discipline of architecture this is an early venture into this area. More could be explored within a tertiary institute like EIT about the values and attitudes of students who do study course related sustainability issues. There are also research opportunities related to monitoring the finished LCP and these are discussed below.

9.5.1 Finishing the LCP

The next stage in this research is to complete the LC building works, furnish it, and prepare it for use. A number of parties are keen to carry on their involvement in the project including the Trades programme, sponsors, and EIT management. Further research will entail investigating these groups and comparing their motivations and changes with the other groups discussed in this thesis. It will be interesting to find out if EIT staff and students will have the same passion for the LCP in the future.

9.5.2 Operating the LCP

A plan for how the LCP will be utilised after it is finished was discussed in Section 6.9.4. It will be beneficial to investigate the values of those using it as a teaching facility. Furthermore, the LCP will continue to be a demonstration facility for schools and the community, so the aim is investigating future visitors and see if the results for the finished building are different from those in the thesis, where the building was yet to be completed.

9.5.3 LCP as a Net ZEB

An aim of the LCP is to be a Net ZEB. Preliminary analysis with the student designers based at the concept stage produced favourable results in that direction. However, monitoring energy production and use together with a detailed LCA will determine the extent to which the LC is a Net ZEB.

9.6 Concluding thoughts

This research has barely scratched the surface in investigating what characterises human behaviour in response to environmental problems and its relationship to the living and building environments. Most participants who chose to be part of the LCP reported some kind of daily environmental habits and, at the same time, demonstrated positive roles among family, friends, and their colleagues at work. On the basis of these limited examples, the sorts of experiences reported appear to be associated with responsible environmental behaviour in small things, linked with strong views with regard to large issues.

The main conclusion of this research is that the success of any kind of initiative is dependent on the involvement of individuals with a particular set of leadership and social skills, such as the author of this thesis. These are what seem to have the most influence on people. Adopting a hands-on approach, and giving a lot of time and energy outside work hours to the project, and in doing so was leading from the front, affected people and made them think about joining in the building effort. The same could be said of the 6 out of a total of 19 design students who were sufficiently motivated to take part in the design of the project refurbishment. However, this also shows that course about sustainability attract those who are already minded to think pro-environmentally. This raises an issue for institutions teaching sustainability.

In order to change the values of people and inspire them to behave more sustainably, something physical or tangible needs to be in place. People need to see a role model doing the sustainable action and they will respond. People may ask, can demonstration buildings make a difference? The answer is yes! But it depends on how it is done, how people are involved in it, and how it is set up. All of these will affect an individual's experience of the project. This is what this research has looked at, and it is significant that people did so many things to support and progress this project that they were not asked to do because of the parsimonious way the project was set up. This says a lot about teaching, because if we as teachers are not prepared to go out there swinging the hammer the students are not going to follow us.

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Appendix 1: Ethics Approval

Phone 0-4-463 5205
Email stephen.marshall@vuw.ac.nz

MEMORANDUM

TO	Mazin Bahho
COPY TO	
FROM	Dr Stephen Marshall, Acting Convener, Human Ethics Committee
DATE	26 June 2016
PAGES	1
SUBJECT	Ethics Approval: 23006 A Demonstration Sustainable Building; An educational tool and medium for investigating environmental values

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 15 February 2017. 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.

Stephen Marshall,
Acting Convener, Victoria University Human Ethics Committee

Appendix 2: Māori Support

WAIOHIKI COMMUNITY
CHARITABLE TRUST

Mr. Mazin Bahho
c/- Eastern Institute of Technology
Otatarā Campus
TARADALE

8 May 2012

RE: Doctoral Research Proposal

Dear Mazin,

I am delighted to confirm the support of the Waiohiki Community Charitable Trust Inc. for your proposal to undertake research around sustainable housing and the human interactions therein.

The Trust was established in 1989 as a social partnership between the Maori and Pakeha families of the Waiohiki area. In 2006, in conjunction with Housing New Zealand Corporation the Trust undertook a Housing Needs Survey of Waiohiki and its immediate environs. What emerged was a clear division between the generally good housing enjoyed by families from the general population and the relatively poor housing suffered by the Maori families.

This led to the suggestion of the establishment of a Waiohiki Rural Housing Trust and a desire to undertake peri-urban planning in the establishment of papakainga housing at Waiohiki. As part of the process of feedback to the HDC District Plan a meeting was held with local Pakeha and Maori landowners. This has led to submissions to the Hastings District Council to have Waiohiki declared as a Special Character Zoneto enable papakainga housing.

All of these elements provide a fantastic tapestry for your research and make it likely that your efforts will contribute to quality housing outcomes for local people by stimulating debate and offering fresh and sustainable solutions to a range of housing needs.

May we wish you all the best in your endeavours. Please anticipate our active participation and support.

Yours sincerely

Denis O'Reilly M Soc P
Chairman

Phone: (06) 845 1698 Fax: (06) 845 1698 Email: wcct@paradise.net.nz Web: www.WaiohikiArtsVillage.com
1184 State Highway 50, Waiohiki, Napier; PO Box 7331, Taradale, Napier 4141

Appendix 3: Student Guideline Brief

Design Brief – Spatial

16 July 2012

**School of Arts
& Design**

BVAD – Level 6
VAD.L6.60
Studio Practice

Duration:
Wks 29 – 38, 41
– 44

Lecturers:
Mazin Bahho,
Roger Kelly,
Jerry Gull,
Anthony
Chiappin, Urs
Blum.

The Log Cabin project: An effective demonstration facility for sustainability.

How can examples of sustainable spaces and practices be presented in order to change the behaviour of the community?

The Project's Objectives:

Public interest in environmental issues is rising. The recent increases in energy and food prices have made hybrid cars and energy-efficient homes common topics of discussion in the media. On the other hand, one of the methods advocated to encourage and promote pro-environmental behaviour in the community is the use of environmental demonstration facilities as effective tools to initiate change in people's attitude towards sustainability.

As a demonstration facility, this design task involves refurbishing the existing log cabin at Otatara Hill (part of the EIT campus) in order to improve its sustainability. The project will be a facility that groups from schools and the community can visit to learn about sustainable practices, ecological living, and creating landscapes that promote pro-environmental practices. Yet the refitted log cabin is also to be used as a home for an artist-in-residence.

The Design Philosophy:

The project aims to be a Net Zero Energy building. It is an attempt to integrate renewable low energy design and environmental impacts of materials.

The strategy will be based on achieving passive standards of ultra low energy demands coupled with specification of integrated technologies, both energy efficiency and renewable. The overall building performance is to comply with the Code for Sustainable Homes in the UK.

By engaging in this project you will showcase alternative sustainable practices, with a focus on the following 'environmental topics';

Sustainable building materials, to consider:

- Materials used for framing and finishing
- Recycling materials during the retrofitting
- Window joinery, recycled
- Bathroom fixtures, recycled fittings

Energy conservation, the use of:

- Utilising passive solar design
- Solar photovoltaic system and solar hot water heating
- Lighting, natural and types of electric
- Energy Star appliances.

Water conservation, including:

- Storing the roof runoff to be used in the facility
- Water heater type
- Recycling gray water
- Black water treatment

Healthy indoor air, including the use of:

- Low or no-VOC paints
- Durable, formaldehyde-free materials for kitchen working surfaces

Sustainable landscape, including the use of:

- A small glasshouse to grow veggies all year round
- Drought tolerant plants and high efficiency irrigation system

Disability consideration design, to consider:

- An open plan to allow movement of people with varying ability levels to move easily.
- Avoid thresholds on doors, and doors wide enough to accommodate wheelchairs

This project will incorporate the following stages;

Stage1: Research

Gathering and analysing information about each of the environmental topics, mentioned above. Each individual will be assigned one topic. Findings will be presented to the group on A3 size sheets for easy photocopying and use.

Stage 2: Project Concept Design

Each student will demonstrate his/ her ideas about the project refit in the form of a design concept. The concept will

demonstrate your ideas, beliefs, and creative solutions guided by the above mentioned 'Design Philosophy'. The presentation includes drawings and models (material or digital). These concepts will be presented to a panel of experts, where one concept (or a combination) will be selected. The panel members will be announced in due course.

Stage 3: Project Parts Design

In light of the selected concept, each individual will be assigned a particular part of the project to work on and develop in detail guided by the overarching ideas of the selected concept.

Focus Group Surveys

This brief is part of a wider research project, which involves various groups (designers, trades people, visitors, etc.). So part of the project includes engaging in focus group interviews to discuss ecological values before and after the project.

Appendix 4: Design concepts judging report

Log Cabin Project
Ashley, Dick, Suzette

3 September 2012

✓ Keep in mind the history

Be sustainable – use what's there.

Have good reasons for what you want to do – another staircase is a lot of money, using resources

Maintain the carcass as much as possible as well as the inside, e.g. kitchen is recoverable

Everything has to have 3 uses: e.g. stairs: storage, inverter/battery bank/go up to the first floor

Interior uses should be part of the efficiency of the building

Maybe think the other way around...Where the power comes from, where might the water go? E.g. where would the waste water go, where will you put all your batteries.

Water group – how are you going to get water into the building?

Windmill – could be good – maybe services the pump for the water. Keep things separate?

Kimberlee – probably not log fire. But fire could be helpful, e.g. cooking facilities, heat, heat water etc. Look into options. Needs to be in the right spot! Old chippie?

Adele – needs to head the services group!

Do some exercises, e.g. appliances – how much do we need to operate a dishwasher, a fridge etc..

Sustainability is about subtraction, e.g. rather than have a shower, have the floor as the shower tray.

Greenhouse great – lots of uses... growing veges, creating heat, place for solar panels, drying room for clothes etc...

Storage options great, e.g. Katie

Brick wall – Deanna – perhaps on the outside? Concentrate floor with bricks? Make an inventory of what's there – what can be used?

Hannah – glasshouse on the side – perhaps mid-way

Dreaming with a constraint!

Appendix 5: Pre-engagement questionnaire

SUSTAINABILITY SURVEY FORM [2]

Project Title: Demonstration Sustainable Building: An educational tool and catalyst for behaviour change.

Researcher: Mazin Bahho

The purpose of this multi-section survey is to investigate your attitudes and opinions on environmental issues. It is totally anonymous so no individual's responses can or will be identified. Thank you.

BACKGROUND QUESTIONS:

Gender: (circle)	Male	Female	Other	How old are you? _____ Years
How would you classify your ethnic affiliation? (circle)	1. Asian	2. Maori	3. Pacific Islander	4. Pakeha/ NZ European
				5. Other _____

SECTION 1:

Please rate each of the following items honestly and accurately. Read carefully, and select the response that best reflects your feeling to the item from 1 (not important) to 7 (supremely important).

People around the world are generally concerned about environmental problems because of their consequences that result in harming nature. However, people differ in identifying the consequences that concern them most. So, looking ahead to the year 2050, are you concerned about the environmental problems in relation to each of the following valued object groups?

Please **circle** one number as your response to the following question;

I am concerned about environmental problems because of the consequences for ,

<i>Plants</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>Marine life</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>Birds</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>Animals</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>Me</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>My lifestyle</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>My health</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>My future</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>People in my country</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>All people</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>Children</i>	Not important	1	2	3	4	5	6	7	Supremely important
<i>My children</i>	Not important	1	2	3	4	5	6	7	Supremely important

(Based on Schultz, 2001)

SECTION 2:

Please answer the following questions honestly and accurately. Read carefully, and select the response that best reflects your feeling to the question or item. There is no right or wrong answer; we are interested in your own personal opinions and perceptions, whatever they are.

Please read the list of issues beside each of the sustainability categories below, use the following scale, and circle as appropriate.

1 Strongly disagree	2 Disagree	3 Somewhat disagree	4 Unsure/ neutral	5 Somewh at agree	6 Agree	7 Strongly Agree				
A clean environment provides me with better opportunities for recreation.				1	2	3	4	5	6	7
Protecting the environment will threaten jobs for people like me.				1	2	3	4	5	6	7
Laws to protect the environment limit my choices and personal freedom.				1	2	3	4	5	6	7
Environmental protection is beneficial to my health.				1	2	3	4	5	6	7
Pollution generated here harms people all over the earth.				1	2	3	4	5	6	7
We don't need to worry about the environment because future generations will be better able to deal with these problems than we are now.				1	2	3	4	5	6	7
The effects of pollution on public health are worse than we realise.				1	2	3	4	5	6	7
Environmental protection will help people have a better quality of life.				1	2	3	4	5	6	7
Environmental protection benefits everyone.				1	2	3	4	5	6	7
Modern development threatens wildlife.				1	2	3	4	5	6	7
Over the next several decades, thousands of species of plants and animals will become extinct.				1	2	3	4	5	6	7
Claims that we are changing the climate are exaggerated.				1	2	3	4	5	6	7
While some local plants and animals may have been harmed by environmental degradation, over the whole earth there has been little effect.				1	2	3	4	5	6	7

(Based on Joireman et al., 2001)

SECTION 3:

Please indicate the extent to which you agree or disagree with each of the following statements by circling one of the set of numbers following each statement that best reflect your degree of agreement or disagreement according to the following scale;

1 Strongly disagree	2 Disagree	3 Somewhat disagree	4 Unsure/ neutral	5 Somewh at agree	6 Agree	7 Strongly Agree
We are approaching the limit of the number of people the earth can support				1 2 3 4 5 6 7		
Humans have the right to modify the natural environment to suit their needs				1 2 3 4 5 6 7		
When humans interfere with nature it often produces disastrous consequences				1 2 3 4 5 6 7		
Human integrity will insure that we do NOT make the earth unliveable				1 2 3 4 5 6 7		
Humans are severely abusing the environment				1 2 3 4 5 6 7		
The earth has plenty of natural resources if we just learn how to develop them				1 2 3 4 5 6 7		
Plants and animals have as much right as humans to exist				1 2 3 4 5 6 7		
The balance of nature is strong enough to cope with the impacts of modern industrial nations				1 2 3 4 5 6 7		
Despite our special abilities humans are still subject to the laws of nature				1 2 3 4 5 6 7		
The so-called 'ecological crisis' facing humankind has been greatly exaggerated				1 2 3 4 5 6 7		
The earth is like a spaceship with very limited room and resources				1 2 3 4 5 6 7		
Humans were meant to rule over the rest of nature				1 2 3 4 5 6 7		
The balance of nature is very delicate and easily upset				1 2 3 4 5 6 7		
Humans will eventually learn enough about how nature works to be able to control it				1 2 3 4 5 6 7		
If things continue on their present course, we will soon experience a major ecological catastrophe				1 2 3 4 5 6 7		

(Based on Dunlap et al., 2000)

Signed:

Date:

Appendix 6: Post-engagement additional questionnaire, Section 4

SECTION 4:

As a result of your visit to the Log Cabin Project, please indicate the sustainable actions you have implemented by circling one of the dots that follow each statement, which best reflect your action or intended action;

Sustainable actions	Done <i>before</i> my visit to the Log Cabin	Done <i>because</i> <i>of what I</i> <i>learnt</i> at the Log Cabin	I intend to do this action <i>in</i> <i>the future</i>
Install additional insulation in home	•	•	•
Upgrade windows to double glazing	•	•	•
Utilise natural light indoors better	•	•	•
Install energy saving lights	•	•	•
Turn off room lights while not in use	•	•	•
Switch power company to one that uses renewable resources	•	•	•
Purchase higher energy star appliances	•	•	•
Install solar panels for electricity	•	•	•
Install solar hot water heating	•	•	•
Use water saving washing machine	•	•	•
Install water efficient toilet and/or shower head	•	•	•
Reduce time taken in daily shower	•	•	•
Collect and store roof run-off water	•	•	•
Install water efficient irrigation system	•	•	•
Recycle grey water	•	•	•
Install black water management system	•	•	•
Change landscape plants to native	•	•	•
Produce compost from kitchen waste	•	•	•
Grow veggies or fruit at home	•	•	•
Install recycled or reused materials or items	•	•	•
Use second-hand furniture at home	•	•	•
Use low or no VOC paint	•	•	•
Use formaldehyde-free materials for kitchen work surfaces	•	•	•

Signed:

Date:

Appendix 7: Student focus group questions

The participants will be asked the following questions:

Pre-engagement Interview: Questions

Biospheric Concerns

Looking ahead to the year 2050, are you concerned about environmental problems because of consequences for 'the biosphere' in relation to:

1. Plants
2. Marine life
3. Birds
4. Animals

Egoistic Concerns

Looking ahead to the year 2050, are you concerned about environmental problems because of consequences for 'you' in relation to:

5. Yourself
6. Your lifestyle
7. Your health
8. Your future

Altruistic Concerns

Looking ahead to the year 2050, are you concerned about environmental problems because of consequences for 'others' in relation to:

9. The people in New Zealand
10. All people
11. Children
12. Your children

(Based on Schultz, 2001)

Post-engagement Interview: Questions

Biospheric Concerns

Repeat questions 1 – 4

Egoistic Concerns

Repeat questions 5 – 8

Altruistic Concerns

Repeat questions 9 – 12

Engagement in the project

13. After being involved in (designing or building) the Log Cabin Project, was there anything you have learned or has inspired you as a result of that work?
14. When do you decide to (design or build) this project? Did you favour sustainable projects over others in making those decisions?
15. Were you attracted to this project because you 'already are' engaged in thinking and behaving environmentally? Or is it because you 'want to' believe in environmental action? What was your motivation force?
16. Were there any models that have influenced your decision to support the project?
17. How important is it to have good examples of sustainable buildings?

Awareness of sustainable building

18. What do you consider a sustainable building to be? Could you describe some qualities a sustainable building should have? Can you give an example?
19. From your point of view, what is your present view about sustainable buildings?
20. What are the important issues regarding sustainability, especially in building?
21. Has considering these issues become a normal part of current building practice in New Zealand?
22. If there are still things to accomplish, and if so, where do you think the effort should be made? Who should take responsibility for further development? How? By what means?
23. Is sustainable building an issue of public awareness or do you think that sustainable building problems can be solved with rules and legislations?

Appendix 8: Sample of notes.

Thematic Analysis: Stage 2. Student Designers pre-engagement

Design Actors: Pre-engagement

Thematic Analysis, Phase 2: Generating initial codes

What's in the data?

This stage is about producing initial codes.

Note: Red text indicates the statement is quoted in the report

Data extract	Coded for
Q1: Biospheric concerns. Are you concerned about the harm that humans are causing to plants, marine life, animals and birds? Looking ahead to the year 2050, how concerned are you?	
(1:37) SD6: Plants create the oxygen that we breathe, they sustain life.	Aware of role of plants in sustaining life on the planet
(1:58) SD1: Bees are important too.	Aware of role of insects in maintaining nature and plants through pollination
(2:13) SD4: We eat plants and animals, that is so important.	1. Concern about food availability for human consumption 2. Concerned about the availability of plants and animals as components of the human diet
(2:20) SD2: If birds don't pollinate, how do plants keep growing?	1. Concern about the continuation of food supply to humans 2. Concern about food availability for human wellbeing 3. Concern about ecosystem survival
(2:52) SD6: Anything extinct is going to impact on us globally, isn't it?	1. Is aware of the effects of extinction of species on the natural environment 2. Need for protection of all natural entities
(3:01) SD2: I am concerned about the animals; I mean you always hear about the kiwi but you don't really hear about anything else.	1. Is passionate about animal wellbeing 2. Education about ecological practices 3. Shown awareness about environmental issues 4. Shown concern about NZ national bird; the kiwi.
(3:24) SD4: Because it is not in NZ.	1. Lack of international news/ info 2. Wondered about the role of media, and other sources of information
(3:30) SD2: You don't really hear about marine life. Nobody here will be able to tell you that these species are going to be extinct.	1. Concerned about lack of info on marine life environmental issues, 2. Realised the need for info, media, other (demo buildings?!)

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(3:55) SD1: There are people who are keeping an eye on that and they tell us for example; stop fishing in this certain area and so on.	<ol style="list-style-type: none"> 1. <u>Information is there but we need to find it.</u> * 2. <u>Where can we find information? (Demo buildings?)</u> *
(4:11) SD6: But the population is not 'slowing down'; it is exploding really at a very rapid rate now, so how can the world sustain that in 2050. It is a serious concern; I don't know how to fix it!	<ol style="list-style-type: none"> 1. Aware of and concerned about the effects of the worldwide population increase on natural capital sustainability 2. Acknowledges that this problem is serious.
(5:35) SD5: I don't know much about . . . but I am concerned about water and rivers.	<ol style="list-style-type: none"> 1. Concerned about the quality of water 2. Showed lack of initiative to environmental education/ research (news, govt agencies, demo?)
(5:58) SD2: A lot of people don't realise how lucky they are in NZ, we have fresh water, and we don't really have pollution. We have a big ozone layer! But we don't wear a mask or drink water from the bottle.	<ol style="list-style-type: none"> 1. Informed about environmental issues in NZ 2. Worried about decrease in ozone concentration over NZ 3. Is aware of the environmental position in NZ.
(6:38) SD1: But we are not as green as we think we are. There are situations where things come up with the water and they just don't know what to do, so they do nothing, which is quite just as bad.	<ol style="list-style-type: none"> 1. Informed about environmental issues in NZ 2. Concern about lack of action towards environmental problems

Q2: Egoistic concerns. Are you concerned about yourself, your lifestyle, your health, or your future? Looking ahead to the year 2050, how concerned are you?	
(8:27) SD1: I think about my kid!	Concerned about the future of own family
(8:38) SD6: We have already thought about it. We are thinking of a lifestyle block and we want to have all eco stuff, it will have a sustainable life style like an autonomous place.	<ol style="list-style-type: none"> 1. Decided with partner on future sustainable living (create own environment) 2. Has responsible environmental attitude
(8:55) SD6: I am looking at health issues stuff at the moment and investigate diet related to health. We want to fix health problems with diet rather than medication.	<ol style="list-style-type: none"> 1. Looks after own health by way of natural diet 2. Avoids health care based on medication
(9:20) SD1: I have been through that road because six years ago I had eczema from head to toe and now everything needs to be looked at in terms of food and what we eat.	Experienced the health consequences of chemical content in food, now she focuses on controlling it through what she eats.

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Appendix 9: Sponsor interview questions

PRE-ENGAGEMENT INTERVIEW: QUESTIONS

General awareness of environmental issues

1. What do you consider a sustainable building to be? Could you describe some qualities a sustainable building should have? Can you give an example?
2. What is your current opinion about sustainable building and environmental issues in relation to the built environment? Have these issues changed or developed during recent years? If so, how?
3. Has considering these issues become a normal part of current building practice in New Zealand?
4. If there are still things to accomplish, where do you think the effort should be made? Who should take responsibility for further development? How? By what means?
5. Could the building process (from design to construction) be changed to suit the aims of sustainable building?
6. Is it relevant for the building sector to distinguish sustainable from other kinds of building practices? Do sustainable buildings demand a different approach to other kinds of buildings?
7. Is sustainable development a field where manufacturers of building products can contribute? How do you see that happening?
8. Is sustainable building an issue of public awareness or do you think that sustainable building problems can be solved with rules and legislation?

Engagement in this demonstration project

9. When do you decide to give sponsorship to a project? Do you favour sustainable projects over others in making those decisions?
10. Are you attracted to this project because you 'already are' engaged in thinking and behaving environmentally? Or is it because you 'want to' believe in pro-environmental behaviour? What is your motivation force?
11. Are there any models that have influenced your decision to support the project?
12. How important are demonstration projects for sustainable building awareness?
13. How important is it to have good examples of sustainable buildings?
14. Should sustainable buildings be evaluated, and how?
15. In your opinion, who is the most important actor for implementing sustainable building?
16. Will you and your staff (if applicable) visit the project when it is finished?

The company and sustainable practice

17. How do you get information about new examples of sustainable practices?

18. Does the company have an environmental profile?
19. Does supporting this project make you and your company more interested in sustainable and environmental building practices?
20. Has the experience you have had so far in engaging with this project make you and your company change the way you consider projects?
21. Are you planning to have some education/ information for the staff about environmentally sound building practices?

The role of media (if there is time)

22. What do you think about the role of the media and reviews for presenting built examples and models to educate the public about sustainable practices?
23. Is it informative for the media to discuss what sustainable building is about?

POST-ENGAGEMENT INTERVIEWS: ADDITIONAL QUESTIONS

General awareness of environmental issues

Repeat questions 1 – 8, followed by these questions:

24. Has this project been of importance to the building sector?
25. What is your present opinion about sustainable building? Has it been influenced as a result of engaging with the project?
26. What is your present opinion about the building sector in relation to sustainable development and environmental issues?

Engagement in this demonstration project

Repeat questions 9 – 16, followed by these questions:

27. Was the project successful?
28. What did you learn?
29. Do you think that this experience can make you and your company change the way you operate?
30. Do we need demonstration projects for sustainable practices?

The company and sustainable practice

Repeat questions 17 – 21, followed by this question:

31. Has the experience you had in engaging with this project made you and/or your company change the way you consider projects?

The role of media (if there is time)

Repeat questions 23, 24, followed by this question:

32. In what kind of media should knowledge and information be published to have any impact?

Appendix 10: Volunteer interview questions

The participants will be asked the following questions:

INTERVIEW QUESTIONS

Engagement in the project

1. When did you decide to offer help to this project? Did you favour sustainable projects over others in making those decisions?
2. Were you attracted to this project because you 'already are' engaged in thinking and behaving environmentally? Or was it because you 'want to' believe in environmental action? What is your motivation force?
3. Were there any models that have influenced your decision to support the project?
4. How important is it to have good examples of sustainable buildings?
5. In your opinion, who is the most important actor for implementing sustainable building?
6. Has the experience you had in engaging with this project made you change the way you usually live or act?

General awareness of environmental issues

7. What do you consider a sustainable building to be? Could you describe some qualities a sustainable building should have? Can you give an example?
8. What is your current opinion about sustainable building and environmental issues in relation to the built environment? Have these issues changed or developed during recent years? If so, how?
9. Has considering these issues become a normal part of current building practice in New Zealand?
10. If there are still things to accomplish, and if so, where do you think the effort should be made? Who should take responsibility for further development? How? By what means?
11. Is sustainable building an issue of public awareness or do you think that sustainable building problems can be solved with rules and legislations?

Correlations between all 7 measures, pre and post visit.

[illegible]

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

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix 12: Quantitative Analysis

Estimated marginal means of all 7 measures, pre-visit.

Table 8: Estimated Marginal Means of T1 group

Dependent Variable	T1_group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
T1_biospheric	EIT staff	6.398	.159	6.086	6.711
	EIT student	5.915	.120	5.679	6.152
	EIT trades	5.533	.232	5.076	5.990
	Enviro Centre	6.448	.183	6.087	6.809
	VAD student	6.462	.105	6.255	6.670
T1_egoistic	EIT staff	5.539	.254	5.039	6.039
	EIT student	5.656	.192	5.278	6.034
	EIT trades	5.567	.370	4.836	6.297
	Enviro Centre	5.528	.293	4.950	6.105
	VAD student	5.519	.168	5.188	5.851
T1_altruistic	EIT staff	6.234	.202	5.836	6.633
	EIT student	5.958	.153	5.657	6.259
	EIT trades	5.667	.295	5.085	6.248
	Enviro Centre	6.156	.233	5.696	6.616
	VAD student	5.966	.134	5.702	6.229
T1_NEP	EIT staff	5.210	.121	4.971	5.450
	EIT student	4.689	.092	4.508	4.870
	EIT trades	4.915	.177	4.565	5.265
	Enviro Centre	5.444	.140	5.168	5.721
	VAD student	5.250	.080	5.091	5.408
T1_AC_EGO	EIT staff	5.896	.160	5.580	6.212
	EIT student	5.815	.121	5.576	6.055
	EIT trades	5.117	.234	4.655	5.579
	Enviro Centre	5.760	.185	5.395	6.126
	VAD student	5.935	.106	5.726	6.144
T1_AC_ALT	EIT staff	6.094	.141	5.817	6.371
	EIT student	6.118	.106	5.908	6.327
	EIT trades	5.533	.205	5.128	5.938
	Enviro Centre	6.175	.162	5.855	6.495
	VAD student	6.168	.093	5.985	6.352
T1_AC_BIO	EIT staff	5.563	.176	5.215	5.910
	EIT student	5.170	.133	4.907	5.433
	EIT trades	5.200	.258	4.692	5.708
	Enviro Centre	5.677	.204	5.275	6.079
	VAD student	5.818	.117	5.588	6.049

Appendix 13: A letter from a visiting group

A thank you letter received following a group visit to the LCP on 20 June 2017.

Dr. Mazin Bahho
Eastern Institute of Technology
501 Gloucester Street
Taradale
Napier 4112
Hawke's Bay

20th June 2017

Dear Dr. Mazin,

On behalf of myself and all of the International Government officials in the ELTO course, I would like to express my sincere gratitude to you for allowing us to visit The Sustainable Log Cabin. We appreciated you giving up your time to talk to us and explain just how the cabin operates.

The Log Cabin has been a really salutary education tool for students who are keen to approach knowledge of renewable energy and off grid power systems as well as being educated to awareness of environmental protection. Your project also gave me some recommendations for ideas about an environmentally friendly house in my country.

We hope that other ELTO groups will be able to visit EIT Log Cabin again in the future.

Yours sincerely,

Truong Nguyen Tuong An
Researcher
Institute of Energy Science
Vietnam Science and Technology Academy
Hanoi, Vietnam

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