Assessment of building products attributes – A comparative study between eco-labelled and non-eco-labelled products available in the New Zealand Market

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Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree - M.Na.R.M.&E.E.

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By

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Green consumers often report confusion about types of sustainable products available on the market; they question a product's durability, reliability and its specific environmental credentials against their non-green counterparts. The construction industry is a very pertinent sector responsible for a high level of energy consumption, hazardous emissions, and waste generation. There is a high demand in New Zealand's construction industry for studies that identify attributes of sustainable products.

The overall objective of this study was to assess sustainable aspects of building products in New Zealand and compare eco-labelled and non-eco-labelled products. The main attributes analysed were performance, retail price, and environmental credentials, including: volatile organic compounds (VOC) emissions, recycled content, hazardous substances, waste and energy management. In addition to comparing eco-labelled to non-eco-labelled products, historical information of eco-labelled products was obtained from the period before the eco-label certification in order to show the main changes that had occurred over time in specific sustainable products. (Note: date range varies between product to product. In the studied sample the range is from 1996 to 2012). The analysis was carried out according to eco-labels standards, the New Zealand Building Code, and New Zealand market trends. Building products studied were restricted to paints, carpets and thermal building insulations. These groups of products were chosen based on a number of criteria, including: different lifespan, importance for New Zealand's consumers, number of manufacturers and retailers in New Zealand, and number of certified products.

The comparative analysis regarding the specific environmental credentials showed that the majority of the organizations with eco-labelled products provide more comprehensive information (such as: chemical components and product performance) for consumers in comparison to non-eco-labelled product manufacturers. Concerning performance, eco-labelled carpets shows a greater improvement than non-eco-labelled ones. Nonetheless, thermal building insulations and paints performance were no different between eco-labelled and non-eco-labelled products. The retail price shows a different figure; non-eco-labelled paints have a lower retail price than eco-labelled ones, while carpets and thermal building insulation provide similar prices between the eco-labelled and non-eco-labelled products. Finally, the historical data analysis indicated that the majority of the organizations did not provide sufficient information about products' specific environmental credentials in the period before product certification. Yet, information obtained from the few organizations that provided historical data demonstrate that the environmental benefits were indeed lower in the period before the environmental certification.

Today, diverse "sustainable" products are available in the market; however, green consumers face barriers (amount and quality of information) concerning the sustainable aspects of these products. This study demonstrates that the extent of information that organizations provide to consumers depends on the level of requirement from external inputs; eco-label products need to comply with comprehensive and strict criteria, thus their manufacturers are obligated to test their products and make the information (findings) public. . Hence, credibility regarding these products' environmental credentials is higher.

A pressing demand for further research is whether building products manufactures are concerned and understand about their products' environmental credentials. How these figures can, at the same time, help nature while saving resources and helping the competitiveness of manufacturers in the New Zealand market. Besides, another area of further research could be how much consumers perceive and care about these environmental credentials in building products.

Key Words: building products, green labels, environmental impacts, eco-labelling schemes

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Content and Structure

This thesis starts with the introduction of the research topic, where the most important characteristics of this study are summarized and the objectives and research questions are given.

Following the introduction, a thorough literature review is presented; the first five sub-sections of the literature review focus on: building industry major environmental impacts, the influence of the consumers in the sustainable building industry, characteristics of green consumers, how consumers choose green products and the main eco-labels characteristics, importance, types, adoption and inhibitors. The literature review concludes with the identification of the research gap. The last sub-section (sixth) of the literature review is a descriptive text with the aim to inform the reader about the main green products attributes related to the building industry.

The subsequent section of this thesis is the methodology; it starts with detailed information and specific technical characteristics from each of the selected product of this research, followed by, the research method section which explain the sampling procedures, data collection and the set of criteria which complemented the data analysis.

Succeeding the methodology section, the result chapter is presented were the reader can visualize in tables and graphs the main findings of this study. This is followed by the discussion chapter where new related information is provided as a form of further conceptualization of this topic. Finally, the conclusion sums up the main themes that this study had undertaken.

Chapter 1- Introduction

The New Zealand government has long tried to improve housing conditions and different measures have been employed to ensure that consumers will have a better quality of living (NZ - Ministry of Business Innovation & Employment 1, 2013). Those measures include providing subsidies to consumers prepared to insulate their houses or install additional sources of alternative energy (EECA1 2013; EECA2, 2013).

The Canterbury region has recently seen its historic building systems violently tested by earthquakes, and the New Zealand government is now in the position to address technical and environmental weaknesses in future building systems (NZ - Ministry of Business Innovation & Employment 2, 2013). At the same time, consumers are reviewing building plans and changes to their existing houses, their consideration of the environmental impacts of buildings products and their maintenance is growing.

Information about the different environmental aspects of building products is overwhelming in variety and uncertain in its quality. Consumers often report confusion, a lack of trust in environmental claims, and lack of awareness of green products available on the market. Hence, the durability, cost and performance of these products are often questioned (Rajagopalan, Bilec & Landis, 2012).

The outcome of this research will reduce the existing information asymmetry between producers and consumers by delivering a review of available products to the New Zealand market and assessing them according to their performance and environmental impact. To maximise the utility of such a study, this research does not only identify environmentally friendly products, but it also compare products labelled as environmentally friendly with the conventional products that do not bear any such a label. Further, the research will also explore how all the eco-labelled products have changed their historical formulae or manufacturing processes to achieve their claims.

Performing these comparisons across all building products is too vast to be addressed by a single study. Hence, this research proposes to narrow the focus to a limited number of representative products so the results can be delivered over the course of a Master's degree. The choice of products should reflect multiple criteria to maximise the value of such a comparative study. Firstly, product groups need to have a large number of manufacturers present on the market. Secondly, the sample product groups need to have some manufacturers that offer products with environmental credentials. These environmental credentials will offer insights into relevant environmental aspects of each product. Finally, there should be sufficient historical data available to plot the development of the green building products' specifications. The products with fit in these criteria are paints, carpets and thermal building insulations.

The proposed review will offer a practical comparison of non-eco-labelled vs. eco-labelled products; it will also examine the development of standards; evaluating the efforts to minimize these products' environmental impact.

This study proposes to assess products attributes based on their performance, durability, cost and environmental credentials. This last attribute will be defined depending on the product, but it will mostly include: Recycled Content; Waste Management; Energy Management; Hazardous Substances/Chemicals Content; Emissions to the Environment and Propensity to Eco-toxicity (see table 1).This research is intended to benefit customers and the building industry. It will provide a current view of the best options for selecting products available on the New Zealand market.

Table 1 - Main attributes description for this study.

Attributes	**Description**
Performance	For paints, the coverage (m2/L) will be considered as performance. For carpets and thermal building insulation, the length of durability (years) will be considered as performance.
Cost	Retail price for New Zealander's consumer
Recycled Content	The amount (in percentage) of recycled substances that a product contains when the manufacture process is finished.
Waste management	Minimization of waste at the manufacturing process and/or Take Back programmes.
Energy Management	Efficient use of energy and usage from renewable sources.
Hazardous substances/chemicals content	Substance from a product that may have a hazardous classification by the NZ HSNO.
Emissions to the Environment (total VOC's and Formaldehyde)	Type and amount of gas emissions that a product releases during the manufacturing, installation and usage phases of its life.
Eco-toxicity	The potential that a product has to negatively affect the ecosystems in the disposal phase.

1.1 Objectives

The overall objective of this study was to assess the main attributes that a range of building products possess, including key environmental credentials and compare this finds with eco-labelled and non-eco-labelled products.

<u>Specific Objectives</u>

1.1.1 To compare eco-labelled vs. non-eco-labelled products across specific attributes:

- Durability;
- Performance;
- Cost;
- Environmental credentials (recycled content, waste management; energy management; hazardous substances/chemicals content; emissions to the environment and propensity to eco-toxicity);

1.1.2 To compare changes in eco-labelled products' attributes over time, more specifically; before and after the certification adoption. (Based on the above attributes and specific historical development of the product group).

1.2 Research Questions

1.2.1 How does the product's performance differ between eco-labelled and non-eco-labelled products?

1.2.2 How does the product's cost (retail price) differ between eco-labelled and non-eco-labelled products?

1.2.3 How do specific environmental credentials differ between eco-labelled and non-eco-labelled products?

1.2.4 How do specific attributes (from eco-labelled products) differ from before the certification period to after the certification period?

Chapter 2 - Literature Review

2.1 Introduction

Today the world supports a society that is energy and resource based. Along with this consumption behaviour, organizations and society are facing a great battle: how to keep growing without depleting the world's natural resources? About 50% of all the natural resources retrieved from the nature are building-related. Also, 40% of the energy that is used (in Europe) is also related to the same industry. Besides that, building related processes produce over 50% of the total waste in most countries in addition to carbon dioxide emissions (Anink, Boonstra & Mak, 1998).

Hence, to mitigate these environmental impacts, the construction industry needs to move towards a more eco-friendly building approach, using efficient energy systems, managing waste, and controlling emissions and water usage. All these factors are also related to the sources of products used in building systems (Bueno, 2010). In the last few decades, environmental awareness from the world population has grown; following this, diverse building products manufacturers are changing their products formula towards a more eco-friendly items for consumption (Elizabeth & Adams, 2005).

2.2 Consumers and the sustainable building industry

Consumers can have strong influence in the sustainable building sector; they show great engagement in decisions related to the type of construction and selection of building products (Martin & Wein, 2007). Green buildings' homeowners often report benefits of energy and water savings, waste reduction, improved indoor environmental quality, greater employee comfort/productivity, reduced employee health costs, and lower operations and maintenance costs (Kats, 2003).

Consumers often report confusion about types of environmental products available on the market, and they often question product's durability, reliability and its overall quality against their traditional counterparts (Leire et al., 2005; Bonini & Oppenheim, 2008; Delmas & Burbano, 2011). This is, however, understandable. Sustainable construction is a complex and evolving trend that takes into consideration many factors that are often hard to measure (Bell & Morse, 2008). Cohen (2010) also asserts that progression toward sustainable building construction is inhibited by a lack of guidance in terms of clear definition of what sustainable building is.

2.3 Green Consumers

The number of consumers interested in environmental and social impacts of products is increasing and their green purchasing preferences have been well documented (Ottman, 1998, 2011; Wang, 2009). Moreover, consumers strive to look for emerging novel products that are associated with environmentally-sound practices (Koebel, Hudson & Cavell, 2004). There are “many shades” of green consumers. As Ottman (1998) describes, people buy green products depending on many reasons such as: belief that is doing the “right”, love for animals, awareness for natural resources conservation and opportunity to reduce costs . Due to environmental friendly campaigns and intensive promotion by different manufacturers and retailers around the U.S.A., 84% of consumers are now purchasing a variety of green products, examples of frequently green purchasing in USA are: energy efficient electronics, low-VOC paints and organic/natural foods (Ottman, 2011).

Today, the green market can be segmented into different groups of consumers according to their behaviour, values and actions. Ottman (2011) describes five groups of consumers: LOHAS, Naturalites, Drifters, Conventionals and Unconcerneds. Consumers that are the most dynamic in favour of the environment are the LOHAS (Lifestyles of Health and Sustainability), normally these consumers are middle-age and educated woman that seek for a healthier environment for future generation. These kind of consumer is able to pay for a product that have a higher cost if it is a green product, besides that they influence others costumers to change brand according to the level of environmental credentials that a product might have.

Naturalites are normally the group that has attained the least educated population and the ones with the lowest income from all the other groups. Besides that, the naturalites have a strong attachment to what is natural and green, especially when there is a relation “green-healthier” product; words such as natural and chemical free. Their purchasing for environmental products is not as strong as the LOHAS, however the naturalites make an effort to buy green/healthier products, in addition they are also keen to learn about this field.

Drifters are the ones that follow the media. Thus, a today protecting nature is a trend; the drifters are the ones that will be guided by this new trend without so much questions, beliefs or research. They do conserve energy and also recycle most of the waste but they are not at the same level or holistic regarding sustainability as the LOHAS. Normally, the Drifters are young adults with a medium-high income.

Conventional are, normally, the ones with the highest income from all the groups, their environmental friendly actions are mostly related to save money such as buy devices that save energy. They are also very attached to the “reduce, reuse and recycle” processes. Green actions for the conventional are mostly practical, where they can do benefit to the environment while also continue built their heritage. Different from the naturalites and LOHAS, the conventional do not seek for organic or natural food as a health care. Most of the conventional are middle-age men.

The unconcerneds, as the name says, are from all groups the least attached to the environmental protection. Normally this group is formed by young men with low income and education. Most of them do not change their purchasing behaviour toward sustainable actions. Figure 1 shows the distribution of these five groups of consumers in the United States of America.

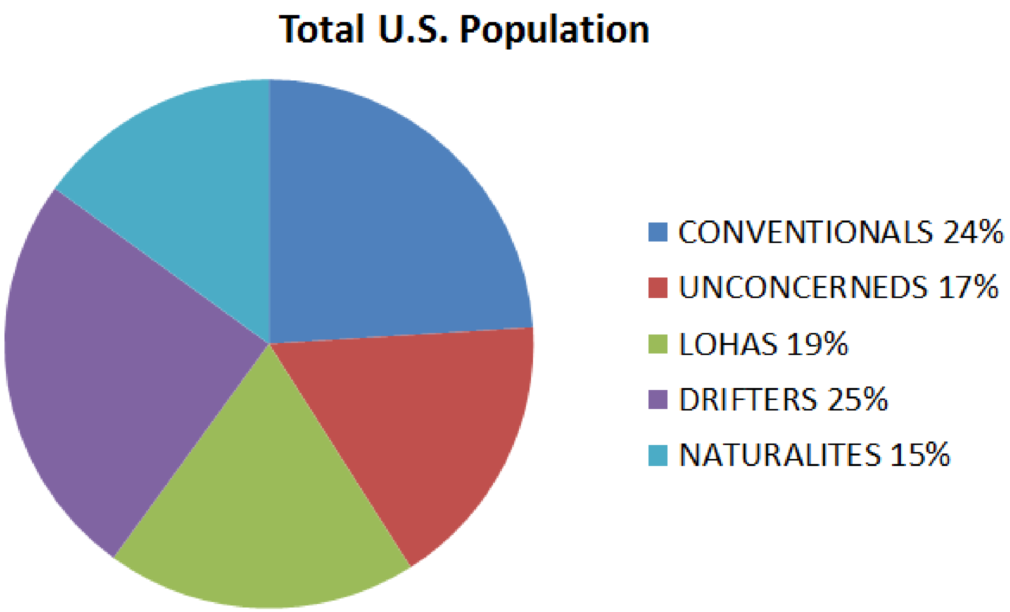

Figure 1- Green consumer segmentation model (Source: Ottman, 2011).

New Zealand, also known as a "Clean and Green" country, possess a society enthusiastic about nature protection and the environment; it is a country that is nuclear-free, uses different zero waste policies and preserves its land and fauna including the establishment of several national parks (Everitt, 2009). The majority (88%) of New Zealand's consumers purchase environmental friendly and social responsible products and 59% says that environmental friendly factors influence their product choice (Green Ideas, 2012). Everitt (2009) claims that: "'Green' is rapidly becoming a core human virtue, like honesty, integrity, diligence, and others."

2.4 How to choose green products?

However, selection of green products still represents a challenge (Leire et al., 2005; Bonini & Oppenheim, 2008). Consumers report confusion about types of environmental products available on the market, and they often question product's durability, reliability and its overall quality against their traditional counterparts (Leire et al., 2005; Bonini & Oppenheim, 2008; Delmas & Burbano, 2011). This is understandable, because sustainable construction is a complex and evolving industry that considers multiple factors that are often hard to measure (Bell & Morse, 2008). Cohen (2010) asserts that progression toward sustainable building construction is inhibited by a lack of guidance in terms of a clear definition of what sustainable building is, and this certainly impacts the decision making process as theconsumers engage in.

Consequently, consumers tend to rely on marketing claims. This information is normally provided by manufacturer and may be misleading and include generic wording such as environmentally safe, recyclable and biodegradable (Howett, 1991), or may be informing of only a single criteria that is required by law for a specific product (such as flammable and toxic) (James, 1997). Therefore, manufacturers' claims may not assist the green purchasing decisions, and consumers are left to search for another source that could guide in the decision process. Hence, it is crucial to understand the advantages that labels and certifications can provide to consumers to avoid misunderstanding or lack of information.

2.5 Eco-labels

Green products are often identified by environmental labels (eco-labels). The objective of eco-labels is to reduce information asymmetry between the manufacture (of green products) and consumers by providing credible information related to the product's superior environmental credentials (Crespi and Marette, 2005). The implicit goal of eco-labels is to prompt informed purchasing choices by environmentally responsible consumers (ECNZ, 2012) without resorting to regulation. Rider, Glass and McNaughton (2011) attest that consumer decision making is challenging due to the variety of different performance and environmental credentials. Significant analysis of the main attributes is required to be able to make a balanced and informed decision when choosing the product.

Some certifications have been developed by independent organizations such as the Forest Stewardship Council (FSC), an international non-profit, multi-stakeholder organization, which issues the FSC eco-label used on wood products that have met their criteria (FSC1, 2012). Products bearing this label have originated from a forest that has been determined to be well managed by an independent, third party organization using international principles and criteria. The FSC requires a chain of custody certification before a product can be labelled. The chain of custody certificate ensures tracking of a wood product from forest to consumer, providing an audit trail that ensures the wood product the consumer is purchasing came from a certified sustainably-managed forest. In December 2008, approximately 107 million hectares were certified to FSC's Principles and Criteria in 78 countries (FSC2, 2012).

2.5.1 Types of Claims

The International Organization for Standardization (ISO) has established standards for environmental labels and declarations. Type I labelling refers to "third-party" certified and independent eco-labelling schemes. These schemes are defined in the standard ISO 14024 and are considered the most reliable eco-labels (ISO 14024, 1999). The type I labelling is based on a detailed process to formulate a standard; whereas once the standard have been established, an independent third party will verify the compliance or not, of the product and the formulated standard (Rider et al., 2011). The FSC certification is an example of type I labelling.

The self-declared claims (Type II labels), also known by "second-party" (Rider et al., 2011), are statements, symbols, or graphics a producer can use in order to indicate an environmental aspect of their product, component, or packaging. Type II labels are governed by the standard ISO 14023 (ISO 14024, 1999). This kind of certification is normally industry-driven, it usually involves an outside consulting company where they have established the standard and verify compliance (Rider et al., 2011).

Finally, the Environmental Declarations (Type III), also known as "first-party" claims (Rider et al., 2011), are built according to structured methodologies such as life-cycle assessment (ISO 14024, 1999). These types of certifications are usually developed by the companies that manufacture the products, and these claims are often not tested or verified by independent organizations. The majority of certifications for green building products are either from Type I or Type II labels (Rider et al., 2011).

2.5.2 Labelling Terminologies

In addition to the many different kinds of certifications it is important to understand that there is a difference between the term certification and standard; certification is related to meeting a criteria, when a product is evaluated and the compliance with a pre-existing criteria is checked (by a third part), whereas the standard is the criteria (or guidelines) against which products will be evaluated (Rider et al., 2011).

Eco-labels are type of green certifications; in the building sector eco-labels are most used to certify products such as paints, carpets, concrete, roof and insulation. The implementation of product eco-labels is part of a major building rating system such as LEED, Green Star and BREEAM and also their residential class rating systems such as, LEED for Homes, Homestar™, Code for Sustainable Homes (CSH) and others. These rating systems verify the whole-building environmental design, whereas eco-labels verify the particular features of individual products based on their specific criteria (Zimmerman, 2005).

2.5.3 Attributes Verification

Certifications can also vary depending on the number of attributes; single or multiple. Multiple-attributes eco-labels verify a number of diverse products attribute. For building materials these might include: indoor air quality (or level of hazardous emissions), recycled content, hazardous substances and waste management (Peri & Rizzo, 2012; Rajagopalan et al., 2012). Examples of multiple-attributes eco-labels are: Environmental Choice New Zealand (ECNZ), Cradle to Cradle, Green Seal, SMART and GreenTag/GreenRate (Ecolabelindex, 2013).

Single-attributes eco-labels, as the name suggests, verify only one attribute. For example, the label ENERGY STAR verifies energy efficiency only and does not measure any other environmental credentials (Peri & Rizzo, 2012; Rajagopalan et al., 2012). Examples of single-attributes certification are: Green Guard ®, ENERGY STAR, Basta and CRI Green label plus (Ecolabelindex, 2013).

Table 2 –Popular eco-labels, their products groups and attributes description.

Eco-Label	Product	Number of Attributes	Attributes Description
Environmental Choice New Zealand (ECNZ)	Several	Multiple	Indoor Air Quality (IAQ), recycle content, hazardous substances, waste management, energy management.
Green Seal	Several	Multiple	Reduced use of hazardous substances and low VOCs emissions
Cradle to cradle	Several	Multiple	Efficient use of water, use to renewable energy, use of safe materials, product and system design etc.
Good Environmental Choice Australia (GECA)	Several	Multiple	IAQ, recycle content, hazardous substances, waste management, energy management.
SMART (Consensus Sustainable Product Standards)	Several	Multiple	Reduction of pollutants, use of green e-power, post-consumer recycled or bio-based materials, reuse or product reclamation, and equity for manufacturer and suppliers.
Blue Angel	Several	Multiple	Recycle content, hazardous emissions, water management, energy management, etc.
Global GreenTag	Several	Multiple	Recycle content, IAQ, eco-toxicity, human health, raw material, hazardous substances, etc.
ECOproduct	Building products	Multiple	Indoor Environment, Health and Environmental Hazardous Substances, Global Warming Potential and Resource Consumption.
Basta	Building products	Single	Hazardous substances.
Energy Star	Electronics, Energy and Appliances	Single	Energy Efficiency
Greenguard	Several	Single	Indoor Air Quality (IAQ)
CRI – Green Label	Carpets	Single	Indoor Air Quality (IAQ)

2.5.4 Ecolabel's adoption worldwide and the in the New Zealand Market

The number of eco-label programs has grown from a mere dozen worldwide in the 1990s to more than 435 programs today; in the building industry eco-labels have grown to 64 programs (Ecolabelindex, 2013).

Information about the international trade of goods with various eco-labels is hard to measure as the eco-labelled products share product codes with the conventional products. Furthermore, variations across countries, economic systems, industries, and environmental concerns, tend to support national programmes over international programmes (Monteiro, 2010). The following graph shows the evolution from different countries adopting eco-labels.

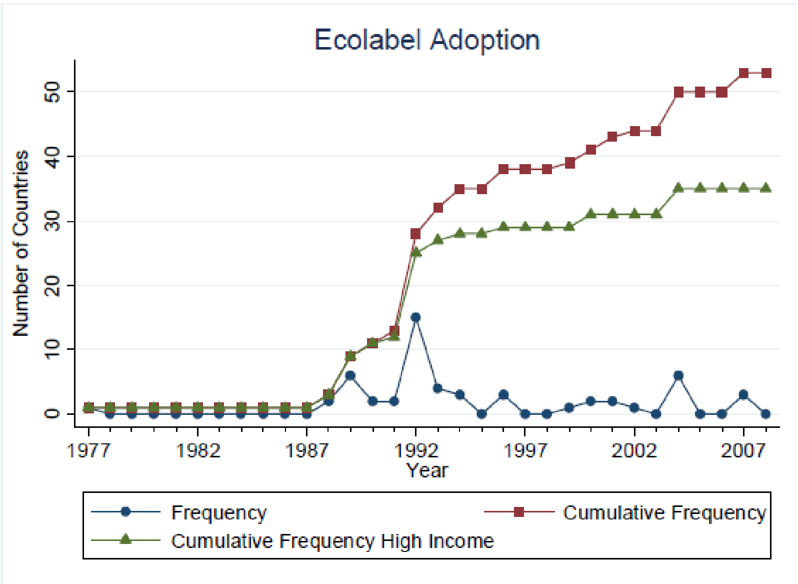

Figure 2 - Eco-label adoption, evolution over time (Source: Monteiro, 2010)

Both national and international eco-labels are present in the New Zealand market. Environmental Choice New Zealand (ECNZ) is the official national eco-label and enjoys the most popularity (Greenstar, 2009; ECNZ,2013a). Multi-national eco-labels are also found in the New Zealand market including: GREENGUARD ®, Carpet and Rug Institute (CRI) – Green Label Plus, Consensus Sustainable Product Standards (SMaRT©), GreenTag/GreenRate and Good Environmental Choice Australia (GECA). ECNZ, Greenguard and CRI – Green Label plus are the eco-labels that are particularly important in this study and they will be addressed in detail.

ECNZ is a multiple attribute and type I (third-party) eco-label, with a high level of credibility. The organization that support this eco-label programme have the endorsement from the New Zealand government, however works independently (ECNZ, 2013a). A study funded by the Building Research Association of New Zealand (BRANZ) titled as "Evaluation of Environmental Choice New Zealand as a

Best Practice Eco-label and Comparison with the GBCA Framework" describes that ECNZ's certification have a high level of transparency, governance and standard setting procedures; this scheme is recognized in the country as well as overseas and is considered as a best practice eco-labelling (Dowdell & BRANZ, 2012).

The building products groups that ECNZ certifies are: Applied coatings, floor coverings, ceiling tiles, engineered wood products, concrete, walls, partitions, joinery, flooring, paints and thermal insulates. Several firms in the country are using ECNZ eco-label, including: Dulux Paints, Resene and Equus for paints; Forbo and Tarkett for floor covering; and Autex, Insulpro and Tasman for thermal building insulates (ECNZ, 2012).

ECNZ has developed a number of different standards; specific for particular product groups and manufacturers are required to meet the criteria of these standards in order to receive the certification. ECNZ's criteria for the majority of the building products contain four main environmental areas: waste management, energy management, hazardous emissions and hazardous materials content, and each of these areas are related to a different environmental attribute. Further, the requirements and specifications to be accomplished are specific to the product group and therefore may vary across product groups (ECNZ, 2012).

The cost that manufacturers incur to obtain ECNZ certification includes: the application fee, the processing fee and the annual licence fee. The application fee is NZD250.00 +GST, the processing fees varies depending on the process of certification, although an estimation value is giving to each manufacturer in prior to the commencement of the assessment, and a 5% administration fee is included in the process fee. The annual licence fee varies accordingly to the company's declared total ex-factory value (total ex-warehouse value for imported product). This fee can vary from NZD750.00 per year up to 17,500.00 (ECNZ, 2013d). Figure 3 shows the adoption of ECNZ label in past years 10 years.

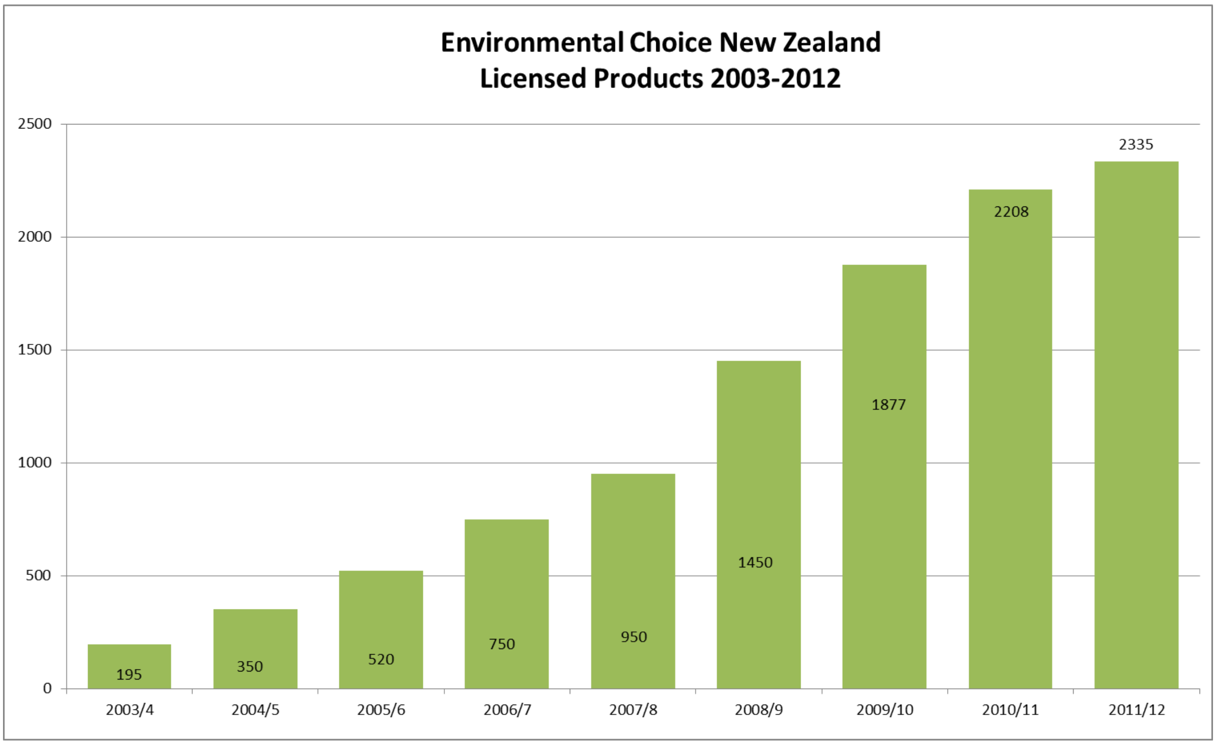

Figure 3 - ECNZ Eco-label adoption (Source: ECNZ, 2013a)

The GREENGUARD certification program, also known by GREENGUARD Indoor Air Quality certification, was launched in 2001 by the GREENGUARD Environmental Institute (GEI) and it has branched into a number of different directions including the creation of the GREENGUARD Children & Schools Certification and the GREENGUARD Building Construction Program (Rossolo,n.d.). Today, GREENGUARD is part of the Underwriters Laboratories (UL) Environment (Greenguard, 2013) and can be found in 38 countries (Ecolabelindex, 2013).

This certification is a single-attribute, based on indoor air quality, it attests that a product need to meet demanding criteria that is mainly related to VOCs emissions for indoor environment. GREENGUARD also provide resources to identify products with a low level of chemical emissions (Greenguard, 2013). An individual standard for a diverse type of building materials, finishes and furnishings was created to certify low emissions products.

This certification is claimed to have a very high level of credibility as a type I (third-party verification) eco-label. GREENGUARD uses a great marketing process, aimed to develop credibility and transparency toward this label. This label, normally, have a higher cost than others third part certifications; however, due to its credibility and strong position in the green market, manufacturers have adopted (Rider et al., 2011).

The CRI – Green label Plus certification was created in 1992, by the Carpets and Rug Institute with the aim to analyse carpets and related products and to identify the products that meet very low VOCs emissions (CRI - Green Label, 2013). CRI is an American trade association representing over 95% of the carpets and rugs manufacturers in the U.S.A. This organization has the aim to provide support and advocate for the carpet industry (CRI - Green Label, 2013, Rider et al., 2011). This eco-label is a second-party or type II certification, where the tests that are supervised by independent laboratories (Rider et al., 2011).

The last two certifications (GREENGUARD and CRI – Green label) are both single-attribute oriented and their focus is on VOCs emission. GREENGUARD uses a single standard for different types of products (such as paints, door, gymnasium equipment and mattresses & bedding), whereas CRI-Green label also obtain a single standard however for a unique product category – carpets and rugs.

2.5.5 Inhibitors of eco-labels

2.5.5..1 Related to manufacturers

Manufacturers are faced with the difficult task of designing and fabricating products that are not only environmentally sensitive, but satisfy consumer needs, and are commercially viable. The products not only need to satisfy the eco-label criteria, they need to satisfy other environmental friendly attributes, be realistically priced and packaged for the market, and adhere to the current building regulations and the building industry demand (Carey, 2006).

Additionally, manufacturers incur the cost of eco-labels certification. As a result, many small innovative manufacturers that produce environmentally sensitive products cannot afford to obtain the certification. Rider et al. (2011) explains that the LEED standard for Indoor Environmental Quality asks for VOC's levels of products. This requirement can be done by two different options; if the product already has the GREENGUARD label, it will pass on the criteria. The other option is to take the test protocol known by CA 1350. The cost for a product manufacturer to do this test is a couple of hundreds US dollars, whereas GREENGUARD certification could cost tens of thousands of dollars.

Moreover, as the certification's criteria diverge, a product might find that its environmental attribute priorities differ from the eco-label's criteria priority (Carey, 2006). For example: Synthetic carpets do not emit a very high level of VOC emission (compared to others building products) but these types of carpets do have a possibility of using a significant amount of recycled materials in their composition. For this reason, a single-attribute eco-label that only covers indoor environmental air quality in their standard is not very interesting. As such, the synthetic carpets manufacturers and consumers may be better served by a different single attribute eco-label or a more comprehensive multiple-attribute certification. Furthermore, there is a lack of information regarding possible durability issue of certain building products and construction practices (Lee, Bennett, Jones, Marston & Kear, 2008) that is not included in the eco-label criteria.

2.5.5..2 Related to the criteria and evaluation of eco-labels

A number of different certifications were developed in a short time and their proliferation generated confusion and doubt for consumers regarding how to choose green products, when the certifications had different criteria and differing evaluation methods across criteria (Rider et al., 2011). The diversity of issues, criteria, and evaluation of these rating systems are numerous.

First, the environmental credentials vary in their comprehensiveness. Consumers understand that a Greenguard product is a sustainable product in some way. However, products that carry single-attribute eco-labels cannot be considered an “overall green product”. The reason is that during the certification process, others attributes such as: recycle content, energy efficiency, hazardous substances, waste management and eco-toxicity may not be verified and could be present in the product. However, the product will have the green label attached to it due to the positive result in a unique attribute required by Greenguard: low hazardous emissions. As there are a vast number of different eco-labels and they verify a variety of different attributes in different ways, it is no surprise that confusion and doubt are common amongst consumers (Rajagopalan et al., 2012; Ottman, 2011; Rider et al., 2011; Kroll, 2009; Zimmerman, 2005).

Also, the required level of a same environmental attribute can diverge across eco-labels; for instance the requirements for VOC emissions for Green Seal eco-label are: 50g/l for flat paints and 150g/l for non-flat paints whereas ECNZ criteria for VOC emissions (regarding paints products) are: 55g/l for flat paints and 60g/l for low sheen paints, besides that GREENGUARD eco-label parameter for VOC’s emissions (for building materials, finishes and furnishings in general) is 0.5mg/m^3 (Jamie, 2008; ECNZ, 2009; Greenguard, 2010).

Third, certifications differ from each other, and sometimes are inadequate for a specific country context; for example eco-labels criteria are normally based on specific attributes such as: level of emissions generation, required raw material and waste management, but the values for these attributes change across countries and their regulation would require the processes/resources to be performed/extracted locally (Bueno, 2010).

Last, as Kroll (2009) describes, a number of “standards of the standard” generate confusion. The consumer cannot easily recognize if a certain certification is a type I, type II or type III, and the credibility and reliability of the certification program’s is prone to under- or overestimation (Kroll, 2009).

This study's research focusses on the lack of information that New Zealand consumers face relating to the clarity and transparency of information regarding the main attributes from green building products.

The following section is related to the product's attributes; especially the main environmental credentials which is included in most building product's eco-labels criteria.

2.6 Products attributes

The main environmental credentials related to building products are in the following areas: Waste Management, Emissions to the Environment and Hazardous Substances/Chemicals Content. Besides the environmental credentials, consumers are also interesting in cost and performance of the products. There are a number of studies (including support references) related to green consumer behaviour and many criteria that green consumers could use to choose a product. Wee (2007) suggests that as societies environmental awareness increase, consumers shape their purchasing behaviour according to how concerned they are for the environment, specifically, how their purchasing will positively (or less negatively) influence the protection of nature. New Zealanders are very attached to nature and their purchasing behaviour is positively changing towards green products (Green Ideas, 2012).

Different attributes can be perceived by consumers in the purchasing moment including: quality/performance, cost, environmental friendliness, brand and convenience. Moreover, consumer values can also influence the choice/priority of the attributes. "Enjoying life and better lifestyle", "Financial Security"," Being happy and healthy", "Feeling good and self-satisfaction" and "The best for my family" are values that support or influence purchase behaviour (Wee, 2007).

This study will focus on the main environmental credentials that building products possess and also analyse the relationship between these credentials with cost and performance. The Following subsections will describe the main environmental credentials of this study.

2.6.1 Waste Management

Due to the increasing population growth and human consumption behaviour, the demand for industrialized products is higher than ever before. Consequently, the amount of waste generation, especially in big urban centres, is a big concern for society. Porter and Vanderlinde (1995) describe waste as synonymous with process inefficiency. Moreover, the costs associated with waste include disposal procedures (in addition to the price of the raw material), energy costs and the containment costs resulting from the proliferation of harmful pests, chemicals, and diseases. Therefore, an efficient consumption/disposal system can both benefit the environment and organisational performance.

According to Dowdell's (2012) "New Zealand environmental profiling plan", 50% of total waste generated in the country comes from construction materials and products and further claims that 58% of the waste disposed in landfills could be used for other purposes, potentially assisting the NZ economy the value of NZ$24.3 million annually.

Construction and Demolition (C&D) waste generation accounts for 4 to 5 times the amount of regular municipal waste (Poon, 2007). Calkins (2009) attests that around 176 million tons of C&D waste is generated in the USA and only about 20 to 30% is reused or recycled. Nonetheless, the building industry has an increasing interesting in developing new strategies to reduce, reuse and recycle the C&D waste (Poon, 2007).

There are diverse forms of waste management such as recycling, composting and disposal (land filling). During the production of building products, different methods can be used to avoid landfill disposal; depending on the material these methods could be recovery, reuse or recycling (Lerner & Wilmoth, 2004). The building sector has the potential to implement waste management in a very efficient way. In terms of reuse and recycling materials the sector can develop products that could have ancillary uses in the construction of buildings, roads, bridges, etc. The recycling process in the building industry is normally considered by mixing leftover materials (designed as waste) with others elements such as sand or cement to develop a new product (Cossu, 2010).

Figure 4 shows an efficient waste management cycle, and the roman numerals identify the order of ideal management techniques. During the industrial process, the first measure that should be taken according to this management technique is to reduce the waste in the source (I). This measure is crucial to avoid the generation of a type waste that can be eliminated by changing processes and efficient utilization of the primary material.

The unavoidable waste can follow two different paths, either be recycled/remanufactured (II) turning the "waste" into "usable" material the industrial process. The remaining waste that cannot be recycled becomes part of the third measure which is the treatment (III). These materials are transformed to avoid becoming future contamination (nature/living species) as hazardous substances. Finally, the untreatable waste, and the fraction of waste that was generated in the treatment process becomes part of the last measurement: disposal (IV). It is important to note that during the recycling and treatment procedures waste may be re-generated, and it should also, be insert into this waste management cycle.

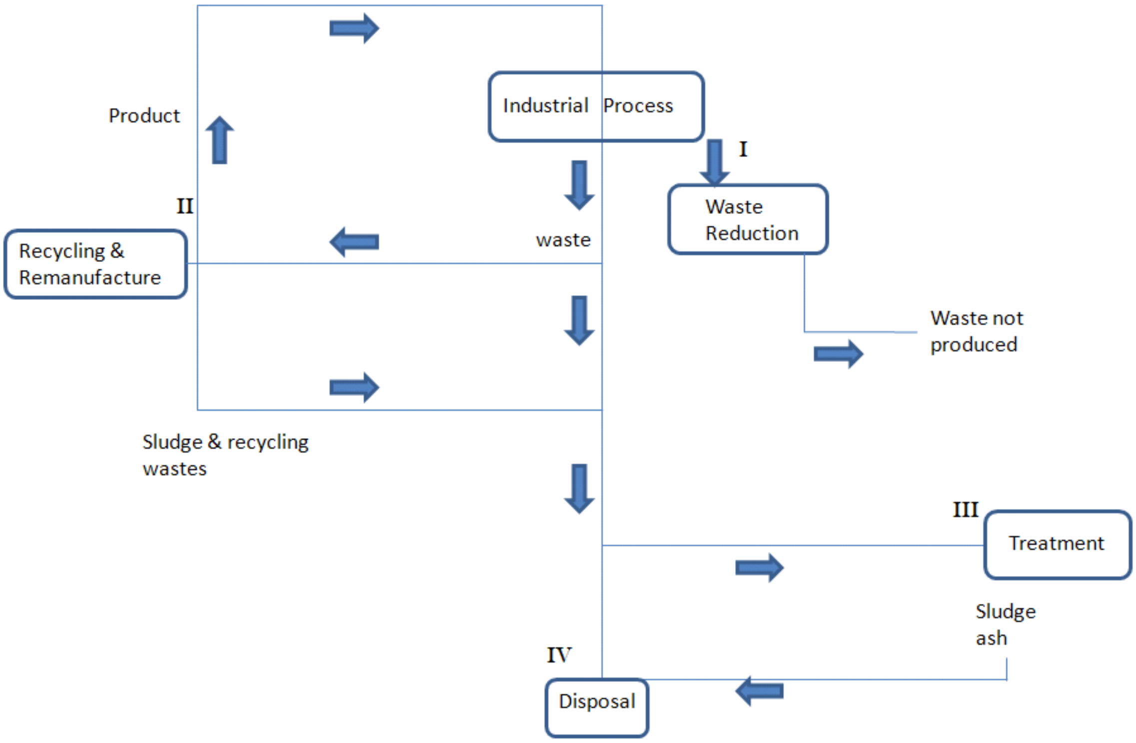

Figure 4 - Hierarchy of techniques for the management of hazardous waste (roman numerals indicate the often used order of each management technique). (Adapted from: Ryding, 1992).

In addition to the benefits that waste management can bring to the building sector and society, there are also issues related to the disposal in landfills, hence raising further reasons to implement an efficient waste management.

The major issue related to the disposal in landfills is the negative environmental impact caused when the waste going into the landfill contains chemical hazardous substances. In the building industry, hazardous substances can be easily found as a waste, and these can be generated in different phases, including the production, application and usage (Ryding, 1992). Figure5 shows examples of hazardous substances that can be found in different products.

Plastics →	Organic chlorine compounds
Pesticides →	Organic chlorine compounds, organic phosphate compounds
Medicines →	Organic solvents and residues, heavy metals, e.g., mercury and zinc
Paints →	Heavy metals, pigments, solvents, organic residues
Oil, gasoline and other petroleum products →	Oil, phenols and other organic compounds, heavy metals , ammonia, salts, acids, caustics
Metals →	Heavy metals, fluorides, cyanides, acid and alkaline cleaners, solvents, pigments, abrasives, plating salts, oils, phenols
Leather →	Heavy metals, dyes, organic solvents
Textiles →	Heavy metals, dyes, organic chlorine compounds, solvents

Figure 5 - Household waste and their generation of hazardous substances (Adapted from Ryding, 1992)

2.6.2 Hazardous Substances/Chemicals Content

In addition to the hazards caused by waste materials, building products in place also carry hazardous substances that are part of the product content. Woodside (1999) explains that there are diverse regulations defining what a hazardous material is, depending on the specific sector such as transportation and building, and also depending on the country-specific regulations. Ignoring the specifics, a simple interpretation describes a hazardous material as a substance that is potentially unsafe to human health or the environment.

Jacquelyn Ottman (2011) claims that in terms of the top environmental issues, 61% of American consumers are mostly concerned about the hazardous, toxic and nuclear waste.

In the building industry, numerous chemicals are used during manufacturing and the hazard level of those chemicals is often very high. Building products are composed of numerous hazardous substances such as: cobalt, zinc, nickel, lead, polyvinyl chloride and others (Seliman & Borai, 2011; Carpet terms, 2011). These substances can be hazardous for human and environmental health depending on how they are used. For instance, they can hazardous during their manufacturing, installation, exposure to other materials, or disposal accidents. For example, the accidental or intentional burning some substances creates dioxins which are very strong carcinogens (Global Health & Safety Initiative, 2008).

Within New Zealand, the Hazardous Substances and New Organisms Act 1996 (HSNO) have been enacted to "protect the environment, and the health and safety of communities, by preventing or managing the adverse effects of hazardous substances and new organisms" (HSNO, 2013). This Act provides guidance to the New Zealand society regarding the many products in the market that contain hazardous substances.

2.6.3 Hazardous emissions to the environment

Another significant environmental and human health concern is the emissions generated by building products. The most cited culprit are the volatile organic compounds (VOCs) released from building products. These include formaldehyde, acetaldehyde, toluene, isocyanides, xylene and benzene (Global Health & Safety Initiative, 2008). VOCs are organic hydrocarbons with a high volatility; they exist in the environment as gases at regular pressure and temperature. VOCs can be easily absorbed in the gas form by the lungs and gastrointestinal track and in the liquid form through the skin. Normally, VOCs are quickly eliminated from the body; however, some VOCs are eliminated more slowly. These VOCs can be found in many different industrial processes such as: cleaning, lubricating, paint thinning, degreasing and stripping (Rafson, 1998).

Assimilation of VOCs in the human body depends on multiple processes, including absorption, distribution, biotransformation, and excretion. Absorption can happen in diverse ways such as inhalation (the most common way), ingestion, or dermal (skin). The more volatile the substance is, the easier it is to be inhaled. When this substance is in the human body, it can provoke different symptoms such as: eye irritation, skin rash and itchiness/ irritation of the throat and nose. Besides allergic reactions, VOCs can also cause visual disorder, breathing irregularity, nausea and headache (Rafson, 1998).

In the building sector, VOCs represent a constant issue for manufacturers. Indoor air quality is very vulnerable when high VOC level products are used. Wolkoff (1997) argues that to preserve good internal air quality, it is crucial to evaluate the chemical impact of each building product when used indoors.

In the last three decades, many issues (such as propensity to toxicity) related to indoor air quality have been raised when taking into account the VOC level. More recently, there has been a greater concern over VOCs because of the efficiency of buildings using sealed windows, well-controlled heating and cooling systems, the use of synthetic materials and also many different products such as copy machines that use materials with a high content of VOC (Rafson, 1998).

Formaldehyde is a chemical that is used to manufacture building materials; it is also an important component for the IAQ – Indoor Air Quality. From the three studied group products, thermal building insulation is the one that possess a higher level of formaldehyde emissions. One of the main characteristic of formaldehyde for building materials can be related to glue and adhesives components as well as a preservative (EPA - United States Environmental Protection Agency, 2013). A variety of health effects can be found in products that have high levels of formaldehyde, and the Global Health and Safety Initiative (2008) recognizes formaldehyde as a known human carcinogen, with other symptoms including: burning sensations in the throat and eyes, breathing difficulty and nausea (EPA - United States Environmental Protection Agency, 2013).

2.6.4 Eco-toxicity

In addition to hazardous emissions, it is crucial to acknowledge the potential to eco-toxicity from products if they are disposed into the waterways (e.g. washing out paint brushes). Nanoparticles (NPs) of metal oxides for instance ZnO and TiO_2 are commonly used in paints products. NPs can cause acute toxic effects in fresh water; some of these effects can be mitigate by the potential that natural water have depending on the metal oxide; however ZnO NPs toxic effects cannot be mitigated by the water (Blinova, Ivask, Heinlaan, Mortimer & Kahru, 2010; Baun, Hartman, Grieger & Kusk, 2008).

2.6.5 Energy Management

A very pertinent environmental attribute is related to energy systems and usage, and "sustainable energy" is an often mentioned catchphrase. It is known that the traditional energy consumption, where organizations and governments find the cheapest (and most of the times non-renewable) solution regarding energy provision, is unsustainable. In the long-term, the consequences of using only non-renewable energy will suffer from the ever-increasing scarcity of these resources (Boo, 2000).

Energy efficiency, renewable energy and reduction of energy consumption are the foundation to create a sustainable energy management (Pinkse & Dommisse, 2009; Boo 2000; Smutny, Neururer & Treberspurg, 2012). These measures are starting to be recognized by organizations, the general public and governments. Milutienė, Staniškis, Kručius, Augulienė & Ardickas (2012) describes that by 31 December 2020 the European Directive in the Energy Performance of Buildings will require that all new buildings should utilize very efficient energy systems (nearly zero-energy buildings).

Besides zero-energy buildings, it is import to consider the embodied energy (energy necessary to produce the building products). Presently, most of the embodied energy is not accounted in the efficiency of the building, even though it is responsible for a large percentage of the total building energy footprint (Milutienė et al., 2012).

Another important energy management aspect in the production of building materials is the source of energy, or whether it comes from renewable resources. There are diverse forms of renewable energy sources such as the sun, wind and moving water. Today, manufacturers are adapting their processes and seeking alternatives sources of energy that can reduce their environmental impact (Kruger & Seville, 2013).Moreover, there is increasing awareness and information about sustainable building products and they are becoming a key indicator for a sustainable energy management (Milutienė et al., 2012). There are multiple environmental credentials related to building products; this study will focus on the more pertinent attributes for each of the selected studied product.

In brief, the literature endorses the significance of green products for the today's consumers in the building industry. Previous studies revealed that product attributes are essential to distinguish different levels of products sustainability. This research evaluates multiple environmental credentials, classified into five main areas: waste management, energy management, hazardous emissions, hazardous substances content and propensity to eco-toxicity. This chapter focused on these attributes since earlier studies have identified them as the most pertinent environmental credentials for building products.

Chapter 3- Methodology

This research has a descriptive-exploratory approach, the method that was used for this study aims to answer the research questions of this study.

3.1 Sampling procedures

3.1.1 Selection of Group Products

This research uses a non-probabilistic sampling process, classified as convenience sampling. The selection of groups of products was based on a number of criteria such as the importance of these building products for New Zealand consumers, the number of manufacturers and retailers in New Zealand and number of certified products.

Due to the large range of groups of building products and also the limited time to complete a Master's degree; this study focuses only on three groups of building products; namely paints, synthetic carpets and thermal building insulates. The decision-making process for choosing these products was based on different aspects that will be described in this section of the methodology.

The primary justification for the selection of the product categories was based on lifespan; as the New Zealand Building Code (2011) describes three different categories related to the life of the product. These are: "Not less than 50 years, not less than 15 years and not less than 5 years". The selected building products for this research fit in these three lifespan categories in this order: Thermal building insulation, carpet and paint.

Also, Rajagopalan et al., (2012) attest that the indoor environmental quality is the factor that raises concerns for many consumers. The same authors attest that building products such as carpet and paint have strong potential to negatively impact the indoor environmental quality when they are not well designed or do not have environmental credentials that consumers might need. Benoit (2012) claims that the major environmental impact concerning the use of residential buildings is from heating and cooling since these processes represent 96% of the energy consumption. Moreover, thermal comfort is a current and promising research topic for New Zealand's housing situation. In addition to comfort parameters, the environmental impact is also a very pertinent concern to New Zealand homeowners.

The following sub-sections will describe the main characteristics of the product groups selected for this study.

Paint

The New Zealand paint market manufactures and sells roughly 25 million litres of paint a year (ECNZ, 2009). Approximately 95% of the paint market in the country is shared by three major paint companies: Dulux, Resene and Wattyl (Responsible Resource Recovery Ltd., 2006). There are a number of diverse factors that influence the decision making process for paint purchasing, but in general, the main drivers are price and quality (Piper, 2006). Although the definition of the word “quality” depends on each consumer’s perspective, most people relate this term to attributes such as durability, performance, low risk to human health, environmental friendliness, and other pertinent attributes (Pontual, 2009; Bueno, 2010). For this reason, it is crucial to display the main attributes of a building product in ways that consumers can make informed product choices.

Product quality is typically directly proportional to cost, and this is certainly the case for paint. In this sector, products which carry a high or medium level of quality can provide greater benefit for consumer such as:

- Easier application procedures;
- Usually fewer coats required;
- Increases resistance to peeling and cracking, and
- Holds the paint’s colour more efficiently (Piper, 2006).

Besides performance, paints also have different categories related to the environmental credentials, but the relationship between quality and environmental credentials is not as explicit as that between quality and performance. Yet, it is known that environmental impacts vary, depending on the phase of the paint lifecycle (Rajagopalan et al., 2012; Wolkoff, 1997; Blinova et al., 2010). The main environmental attribute related to paints is the release of harmful elements into the environment, and the section “2.6.3. Hazardous emissions to the environment” of this thesis explains some of the most common emissions that building products can emit. Of the three selected products, paint has the highest levels of VOC emissions (ECNZ, 2008; ECNZ, 2009; ECNZ, 2010). Similarly, this product group is also associated with other environmental impacts such as: hazardous content (such as heavy metals, harmful solvents and others) and disposal of unwanted paints.

Considering characteristics from paints composition will assists the reader to understand the environmental impacts that this product can cause. The ingredients used in paint represent most of the times the primary attributes related to hazardous emission to the environment .

Paints are mainly composed of: pigments, binders, liquids (solvents and diluents) and fillers (or additives) (Rider et al., 2011).The durability of the paint can be closely related to the concentration of these components (Piper, 2006). The pigment is the substance that provides colour to paint and its concentration is expressed as a percentage; an ideal number for most regular paints is 45%. The level of pigment volume concentration is directly related to water permeability. Consequently, the more pigment a certain paint has, the higher the risk is for the paint to be susceptible to rusting and blistering. Another factor related to the pigment level is the gloss (or sheen) of the paint; the less pigment the paint has, the more gloss it will obtain. In general, a paint that has a high level of gloss will be more attached to the wall, it will be easier to clean and more durable (Piper, 2006). Natural (environmentally friendly) options of pigments can be exemplified as: charcoal, clays, nuts and carbon (Rider et al., 2011).

Another significant paint component is the binder, which is also known as the "base" of the paint. The most traditional binder elements are oil, latex or water (Rider et al., 2011). The binder is the substance that protects the pigment and binds it to the surface. Usually, the more binder a paint has, the better the quality, as well as increased adherence, durability and resistance (Piper, 2006). The kind of base used depends on the type of surface to be painted; interior walls and ceilings, exterior wood and rusty metal. Natural binders have recently entered the market including: milk curd, lime, vegetable oils and animal chalk. Also, clay based wall finishes are starting to be used as a very common environmentally friendly alternative for binders, and are available from some manufacturers (Piper, 2006; Rider et al., 2011).

The liquid carries the binders and pigments (solids parts), which in regular paints occupies between 25 to 50% of the volume. The liquids are made by two different elements: diluents or solvents. The solvents are dissolved and mixed with the binder to embrace with the pigment and turn the paint into a more homogenous substance. Contrarily, the diluents do not dissolve the binder and pigment but hold them in suspension. A high concentration of diluents is a sign of low-quality paint (Piper, 2006). Finally, fillers or additives assist the other components to provide better finishing properties. Examples of fillers and additives are thickeners and modifiers, de-foamers, and co-solvents (Piper, 2006). Conventionally, all the fillers/additives contain synthetic elements with VOC's (Rider et al., 2011). Rider et al. also claim that about 300 toxic chemicals and around 150 carcinogenic substances can be found in paints.

Overall, the main characteristics from the paints composition related to this study influence the proposed attributes (VOC's emission, performance, eco-toxicity and others). For instance, natural pigments can benefit against eco-toxicity. Also, binder and liquids assist achieving a higher quality cover (performance). The level of pigment influences the glossiness of the paint; this in turn affects the level of VOC's emission.

Carpet

Although New Zealand's carpet market offers different types of fibres, the main carpet fibre in the country is wool (Carpet, 2013). This product choice is influenced by the fact that the wool industry is one of the largest in the country. In 2010, New Zealand raised 32 million sheep, but in the 1980's this number was closer to 70 million (Conforte, Dunlop & Garnevska, 2010). Besides the quantity, New Zealand's wool is internationally renowned for its high quality (Carpet, 2013). However, the prices of wool carpets are typically higher than the synthetic carpets (Go green flooring, 2013; Woolshire, 2013). Apart from wool, there are also other natural fibres that can be used in carpets. The majority are plant-based and include: sisal, grass, corn, and sea grass (Rider et al., 2011).

The New Zealand carpet market also offers synthetic carpets made from polymers, olefin (polypropylene), PET and acrylic (ECNZ, 2008). Synthetic carpets do not possess a renewable component as all bio-based carpets do; although some synthetic carpet manufacturers are reviewing their processes in order to remain competitive in the new generation of green markets. Examples of green measures are: recycling processes using post-consumer and post-industrial waste, reducing VOC emissions and avoiding/reducing the use of hazardous elements in the manufacturing process (Carpet Recycling, 2013; Rider et al., 2011; ECNZ, 2008).

Post-consumer wastes are generated by diverse processes; across numerous industries, commercial establishments, and from a variety of products. However, to be recognized as a post-consumer waste, it has to come from an end-user of the product. Post-industrial waste diverges from the post-consumer waste due to the fact that the industrial waste generated by manufacturers may still be used (as raw material) if it is fed back into the production process (ECNZ, 2008).

In contrast to the new-generation of green synthetic carpets, there are traditional synthetic carpets which usually consume a great amount of energy in the manufacturing process, release of atmospheric pollution, as well as other kinds of negative environmental impacts. Most of these traditional carpets have petroleum-based synthetic elements such as: acrylic, nylon, polypropylene and polyester. In addition, some of these carpets can contain potentially harmful substances such as PVC, SB latex, styrene, and vinyl benzene. These carpets also undergo fire retardant, fungicide, anti-static, and stain-resistant chemical treatments (Rider et al., 2011).

Carpeting widely varies with respect to durability, price, recycles content, hazardous content, and emissions. Furthermore, most carpets can be installed in two different forms: tiles or broadloom (rolled carpets). Kruger and Seville (2013) explain that tiled carpets are easier to uninstall and recycle.

Nylon carpets are very popular around the world with their main advantages being resistance to wear and ease of dyeing. Because manufacturers are widespread, nylon carpet is a “readily available product” for many countries. Nylon carpets are differentiated by their fibre; some carpets can have a type 6.6 nylon, which is marketed as having a better quality than the type 6 nylon. Nonetheless, it has been discussed by chemical engineers that the carpet construction phase has more value for the final quality of the nylon carpet than fibre type number (Carpet College, 2013).

The polyester carpets, also known as PET carpets, are commonly produced using recycled plastic bottles. Other advantage for this kind of fibre is stain and abrasion resistant, it does not involve chemical treatments such as other nylon based carpets, and has a higher melting point (Go green flooring, 2013; Carpet College, 2013). PET is also known for holding its colour, and resists colour loss from excessive sunlight or severe cleaning. In addition, due to the food grade (high quality) of the recycled PET, the carpet made by recycled PET contains high quality resins. Maintaining PET carpet fibre is also easier than most of the competitive carpets so it also decreases the need for chemical cleaners that have the potential to release VOCs (Go green flooring, 2013).

The olefin carpet has a special feature; it has a very fast dying process. It also has a great potential to be stain resistant. Therefore, this kind of carpet can be used either for the indoor or outdoor environment. This fibre is popular in the market due to its low cost. However, the olefin has a low melting point, as well as a low durability standard and is also not as soft and comfortable and has a fibre quality lower than most of the other kinds of carpets such as nylon, PET and wool fibre (Carpet College, 2013; Carpet dying, 2013).

Despite the several varieties of carpets in the New Zealand market, only the synthetic carpets are analysed in this study because no natural fibre carpets have the New Zealand official eco-label - ECNZ (ECNZ, 2013b).

The compositions of these synthetic carpets normally are:

“A) polymer and high polymer / wool fibre blend (such as 80% polymer and 20% wool) modular carpets which include nylon (both type 6 and 6.6) and nylon blends, olefin (polypropylene), polyester (PET), acrylic and wool delivered to market as Commercial Modular Tile Carpets.

b) Polymer fibre carpets which include nylon and nylon blends, olefin (polypropylene), polyester (PET) and acrylic, delivered to the market as broadloom residential and commercial carpets.” (ECNZ, 2008)

To sum up the main environmental credentials related to synthetic carpets are based on the following categories:

- recycled component of face-fibre and backing;
- refurbishment and other waste minimisation initiatives and;
- VOC Emissions. (ECNZ, 2008)

Hence, these are the main relevant synthetic carpets attributes for this research.

Thermal building insulation

Wilson, Piepkorn, Building Green and Ebrary, (2008) claim that “any insulation material is a green product.” This statement comes from the fact that insulation properties can diminish the need for cooling and heating spaces, ultimately reducing energy use and environmental impacts.

The design and type of material used in a building are crucial aspects for the thermal comfort of a house (BRANZ, 2010). When insulation is installed in the walls, floor and ceiling of a house, air flow through the house decreases, and consequently the system works with less loss of heating (in winter time) or cooling (in summer time).

Kruger and Seville (2013), claim that: “the air flow is one of the most important forces that can affect building performance”. This happens because air flow is responsible for heating and cooling processes. Heat movement can occur in different ways: conduction, convection or radiation (Rider et al., 2012). Conduction applies to solid materials (such as metal, glass, wood and plastics); while convection applies to fluids (liquid or gas).Radiation is the movement through electromagnetic waves from one surface to another (Kruger & Seville, 2013).

Heat tends to disperse into cooler areas; air moves from areas of high pressure to areas of low pressure. However, when air flow is inhibited, it can promote a much longer heating or cooling in a determined space (Rider et al., 2012).

A regular house loses heat from different areas, mainly through the floor, roof, windows and walls (Figure 6). The heat lost depends on the level of insulation that the house has. For example, if a house does not have any insulation, most of the heat is lost through the roof. However, when a house has proper insulation (meeting the building code requirements), the total heat loss is very low compared to the first scenario while shifting the focus of heat lost to the windows. An insulating material prevents the heat diffusion because of its thermal properties and its thickness (Kruger & Seville, 2013). Insulations are made from different materials with different properties. Examples of insulation materials are: Glasswool, Wool, Polyester, Mineral wool, Cellulose, Cotton and Foam insulations (BRANZ, 2010).

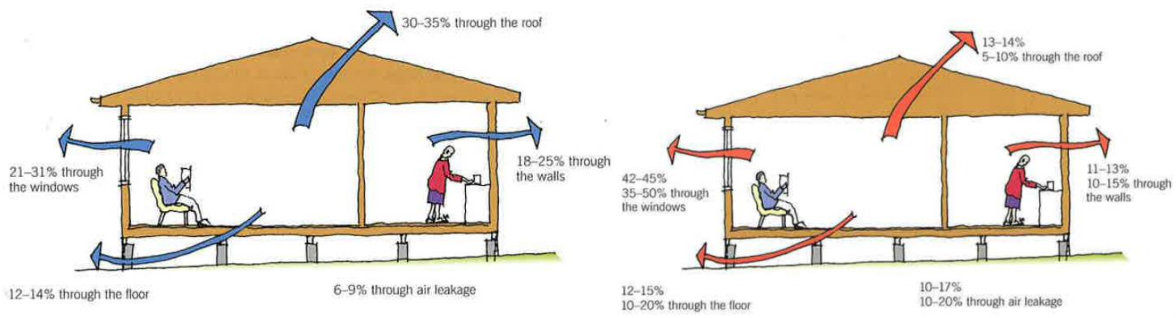

Figure 6 - Heat loss from a non-insulated (left) and an insulated (right) house. (Source: BRANZ, 2010)

The material that thermal building insulation is made varies; around the world the most used materials can be divided in two different main groups:

- <u>Inorganic Materials</u>

Where the most common component comes from the same material as the glass; it is usually in a foam glass texture or fibrous type texture which can be glasswool (fibreglass) or stone-wool.

- <u>Organic Materials</u>

This group can be very diverse however the most common materials are: cellulose, sheep wool and cotton wool as fibrous materials; and expanded polystyrene, extruded polystyrene and Polyurethane foam as part of the foamy type materials (Papadopoulos, 2005).

Glasswool, (also known as Fiberglass in US) is the most common type of insulation material in New Zealand. Its main components are silica sand, limestone and soda ash (Rider et al., 2012). The air flow reduction efficiency of glasswool is about 15 to 20% and today some manufacturers use about 30% of recycled materials in the composition of their products (Wilson et al., 2008). Besides that the raw material for this type of thermal building insulations can easily reach up to 85% of recycled glass (Level, 2013).

Glasswool insulation was made in the past using phenol formaldehyde to embrace the fibres; nowadays it is most commonly made using acrylic and a few bio-based binders (Kruger & Seville, 2013). However, the New Zealand market still has a great amount of insulation brands that still use formaldehyde in its composition. Due to the great role that this compound plays in the thermal building insulation products; the present study analysis considers (only for this product group) formaldehyde separate from the other VOC's compounds (as formaldehyde is also a fraction of VOC). Hence, VOC's emissions will be named as total VOCs (TVOCs) emissions for thermal building insulation products and another environmental credential: formaldehyde emissions is designed for the analysis.

Despite the known advantages of glasswool, there is an apprehension that airborne fibre (elements used in some glaswool insulations) might be carcinogenic (Wilson et al., 2008). Nonetheless, these claims have not been substantiated. For instance, Rider et al., (2012) cites the suspicion concerning the potentially carcinogenic substance; claiming that: it “is no longer; however, substantial safety concerns remain.” However, it is important to note that some health problems may occur during the installation phase of glasswool insulation (Rider et al., 2012), and some of the immediate effects include skin, eye, nose and throat irritation (BRANZ, 2010).

Wool (sheep) insulation is also a popular insulation type in New Zealand (ECNZ, 2010). This type of insulation has little embodied energy because of its little processing (Kruger & Seville, 2013). The use of wool for insulation has a great advantage for the environment as it is a renewable product. However, no wool-type insulation is certified by ECNZ (ECNZ, 2013c).

Another insulation material is polyester, a synthetic fibre made from polyethylene terephthalate (PET) polymers derived from petroleum (Fletcher Insulation, 2013). In comparison to glass wool, polyester and wool are easier to handle and most of the time do not cause skin irritation. However, polyester can be more difficult to cut than glasswool (BRANZ, 2010). Polyester insulation manufacturers are starting to recycle and process plastics drink bottles (made of PET) to manufacture polyester insulation.

Apart all the above types of materials, some insulation are made using combined materials, for instance thermal building insulations made from wool and polyester (Papadopoulos, 2005).

From all the cited environmental credentials of this research, insulations can have a high influence in recycle content attribute (Wilson et al., 2008), as the glasswool insulation can have a minimum recycle content of 45%, while Polyester also has a minimum recycle content of 20% (ECNZ, 2010).

3.1.2 Selection of products and manufacturers

The sampling process for the selection of products and their manufacturers is also classified as convenience sampling and it is based on the availability of information. Products should all be part of the New Zealand market and at least a few of them should have the majority of the market share, for example, for the paint category, products were chosen from the three major manufacturers (Resene, Dulux and Wattyl) which together hold about 95% of New Zealand’s market share.

3.1.3 Determination of the sample size

The number of manufacturers varies depending on the availability in the market; it was selected six manufacturers for paints, eleven manufacturers for synthetic carpets and nine manufacturers for thermal building insulation. In total, 38 building products were selected from the New Zealand market.

Products from each manufacturer have a high level of homogeneity (with respect to the environmental credentials); for this reason, it was stipulate for some building materials that a number of 1 to 3 eco-labelled products would be selected from each manufacturer and around the same number for the non-eco-labelled products, depending on the specific characteristic from each product type.

3.2 Data collection

The data for this research is secondary data using external sources. This data collection was based on three main steps. First, general information was assessed (in the form of a literature review) regarding green consumer behaviour, the main environmental impacts of building products, the specificities of the most important eco-labels for building products in the New Zealand market, the main characteristics of the selected group products and their main environmental credentials. Secondly, a detailed analysis was performed on the standards from the most popular building products eco-labels in New Zealand such as: ECNZ, Greenguard and CRI. Finally, product specific data was obtained based on manufacturers' information.

A more detailed procedure of the main steps is discussed as following:

a) Information gathering

The literature review was written focusing on relevant previous studies and world-wide eco-label characteristics. Detailed information about environmental label criteria enabled the consumer to distinguish the major environmental impacts that are caused by these group products: paints, thermal building insulation and synthetic carpets.

Key specificities from the selected group products were also reviewed, such as: different type of products materials (i.e. glasswool and polyester insulation), detailed composition of the product, performance of the product and what affects it, specific or more likely impacts that each product can cause, environmentally friendly characteristics that each product may have and its market share in New Zealand.

This information gathering provided a knowledge foundation for the research design and data collection.

b) Eco-labels standards review

A detailed analysis of documents was carried out with the main sources for the criteria (standards) were from: ECNZ – the New Zealand Eco labelling trusts (official New Zealand Label), Greenguard-Environmental institute and CRI – Green label (The Carpet & Rugs Institute USA). The documents that were analysed from ECNZ were the licence criteria for paints (EC-07-09), licence criteria for thermal building insulates (EC-25-10), licence criteria for thermal (resistive-type) building insulates (EC-25-09 and EC-25-12) and licence criteria for synthetic carpets (EC-33-08 and EC-33-12). The document analysed from Greenguard was the "Greenguard indoor air quality (IAQ) standard for building material, finishes and furnishings". From CRI – Green label plus, the document that was analysed was the "CRI green label plus carpet program – carpets emissions test criteria". Also examined was the Emission testing method for California specification 01350 known as: "Standard methods for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers", which is the standard that the Green Label Plus also uses in their verification process.

These documents showed how each of the environmental product's attributes could be related to an environmental impact. The analysis of the documents lead to detailed characteristics of the main attributes of each product group. For example, the synthetic carpet's main environmental credentials became: "recycled component of face-fibre and backing, refurbishment and other waste minimisation initiatives, dyeing process and VOCs emissions". These standards provided the minimum requirements that products should meet (i.e. EC-25-09 says: "… the face fibre for all Solution Dyed virgin tile products shall contain 10% or higher total recycled content by weight…") in order to comply with the standard.

c) Collecting products specific data

Products specific data are the values from each product's attributes. Examples of this data for the general attributes are: retail price, warranty/durability and coverage (for paints). Examples of this data for the environmental attributes are: percentage of recycled content, percentage of waste minimization, amount of VOC emissions (normally in g/l), usage of renewable energy, if there is a hazardous substance in their composition, and others.

Product specific data were collected using several tools, such as: manufacturer's websites, phone calls, emails and also going in person to meet manufacturers or retailers and view the physical products. Most of the data were displayed in documents such as: MSDS (material safety data sheet) and general product data sheets. Specific product data could also be displayed on the webpage's body of the manufacturer/retail and on product packaging. To be able to obtain historical data from products; the internet archive ("wayback machine") was the main tool to collect this data, apart from the contact with manufactures and retailers.

It is important to note that there were information discrepancies between the manufacturers' websites and the certification body's website (for the same product). When this occurred, the manufacturers' information was used (see discussion chapter).

3.3 Data Analysis

Due to the qualitative nature of this research, a set of criteria was defined in this section to guide the analysis of this study.

3.3.1 Focus of the study and assessment criteria

The overall objective of this study was to assess the main attributes that a group of building products possess (including key environmental credentials) and compare these across eco-labelled and non-eco-labelled products.

Answers to the following research questions lead to completion of this study's main objective. A set of criteria were described for each research question with the aim to assist the measurement and analysis of this work. These criteria were based on parameters such as the NZ building code and official certification criteria (such as ECNZ and Green Guard). Colours were set to describe whether the attribute values were below the criteria (red colour), above criteria (green colour) or exactly at the criteria (black colour).

<u>RQ1 –How does the product's performance differ between eco-label and non-eco-label products?</u>

Obs.: This research question was evaluated through different criteria for each product, paint's performance was evaluated based on its coverage; and both carpet's and insulation's performance were related to their durability (Table 3).

<u>Criteria for paints:</u> Coverage -7m^2/l.

Based on New Zealand's most popular paints data sheet, the theoretical coverage (m^2/L), considering a normal interior wall surface, should be at least 7m^2/L.

Criteria for carpets: Durability- 15 years.

According to the NZ building code (New Zealand Building Code, 2011).

Criteria for thermal insulation: Durability - 50 years.

According to the NZ building code (New Zealand Building Code, 2011).

Table 3 – Criteria set for product's performance

	Attribute	Red	Black	Green
Paints	Performance (coverage)	<7m2/L	NOT KNOWN	≥7m2/L
Carpets	Performance (Durability)	<15 years	NOT KNOWN	≥15 years
Insulation	Performance (Durability)	<50 years	NOT KNOWN	≥50 years

RQ2 –How does the product's cost (retail price) differ between eco-label and non-eco-label products?

Criteria: A difference will be considered if 40% of the price from the more expensive products is still higher than the cheapest product; cheaper prices will be assigned with green colour, whereas the more expensive ones will be assigned with red colour.

For instance, if the cheapest paint product costs NZ$10.00 per litre and the most expensive cost NZ$30.00 per litre, the cheapest product will be displayed in green. The red colour will be set depending on how much more expensive the other products are comparing to the cheapest price (NZ$10.00). In this case, the NZ$30.00 per litre product will be displayed in red as 40% of NZ$30.00 is NZ$12.00 (which is higher than NZ$10.00). Other products, in the middle range, will vary depending on whether 40% of this price is more or less than NZ$10.00.

RQ3- How do specific environmental credentials differ between eco-labelled and non-eco-labelled products?

Each of the following criteria is created based on the subsequent ECNZ standards:

Licence Criteria for Synthetic Carpets - EC-33-08 and EC-33-12 (ECNZ, 2008).

Licence Criteria for Paints - EC-07-09 (ECNZ, 2009).

Licence Criteria for Thermal Building Insulates- EC-25-10 andEC-25-12, also licence criteria for thermal (resistive-type) building insulates - EC-25-09 (ECNZ, 2010).

CRITERIA FOR PAINTS (Table 4):

VOC's emissions:

- For low sheen paint's VOC emissions- 60 g/l
- For flat paint's VOC emissions - 55 g/l

Recycle content: Percentage of recycled content from paints products (ECNZ does not require recycled content for paints products).

Hazards identification (according to NZ HSNO regulations): If the paint has a "hazardous" or "non-hazardous" classification.

Waste Management: If manufacturers contributes or not to a "zero waste" project or use measures to reduce their waste. Basics disposals considerations will not be valid as a positive waste management initiative.

Eco-toxicity: If a manufacturer informs or not the possibility of eco-toxicity when rest of paints (leftovers) are disposed in waterways.

Table 4 – Criteria set for paint's environmental credentials

	Attributes	**Red**	**Black**	**Green**
Low sheen paints	VOC's emissions	>60 g/l	=60 g/l	<60 g/l
Flat paints	VOC's emissions	>55 g/l	=55 g/l	<55 g/l
Paints	Recycled content	Zero	NOT KNOWN	Any
Paints	Hazards identification	Hazardous	NOT KNOWN	Non-hazardous
Paint's Manufacturer	Waste Management	No	NOT KNOWN	Yes
Paint's Manufacturer	Eco-toxicity	No	NOT KNOWN	Yes

CRITERIA FOR CARPETS (Table 5):

Recycled content of face fibre: if at least 10% of the carpets' face fibre material comes from post-consumer and/or post-industrial waste.

Recycle content of backing: if at least 20%of the carpets' backing material comes from post-consumer and/or post-industrial waste.

Overall recycle content: if at least 15% of the overall product material comes from post-consumer and/or post-industrial waste.

Take Back programme: if manufacturers contribute, or not, to a Take Back programme.

Waste Minimization: how much (in percentage) manufacturers reduced their waste (comparison from previous years) during the manufacture process.

Energy management: if manufacturers use energy (partially or solely) supplied from renewable sources or utilizes measurements to reduce consumption.

Total VOC emissions: if a product emission value comply or not with a well-known certification criteria.

Table 5 – Criteria set for carpet's environmental credentials

	Attributes	Red	Black	Green
Carpets	Recycle content face fibre	<10%	= 10%	>10%
Carpets	Recycle content backing	<20%	= 20%	>20%
Carpets	Overall recycle content	<15%	= 15%	>15%
Carpet's Manufacturers	Take Back programme	No	Not Known	yes
Carpet's Manufacturers	Waste Minimization	<10%	= 10%	>10%
Carpet's Manufacturers	Energy	No	Not Known	yes
Carpets	Total VOC's emissions	>0.5mg/m^3	Not Known	<0.5mg/m^3

CRITERIA FOR THERMAL BUILDING INSULATION (Table 6):

Recycled content for Glass Wool: if at least 45% of the overall products material comes from post-consumer and/or pre-consumer waste.

Recycled content for polyester: if at least 20% of the overall products material comes from post-consumer and/or pre-consumer waste.

Recycled content for wool: when 100% of the overall products material comes from post-consumer and/or pre-consumer waste.

Hazardous content: If the product satisfies or not the New Zealand Building Code (NZBC) F2 clause.

Waste Management: If manufacturers contributes or not to a "zero waste" project, and/or uses measures to reduce their waste.

Total VOC emissions: Maximum emissions 0.5mg/m3.

Formaldehyde emissions: Maximum emissions 0.05ppm.

Energy Management: If the product satisfies or not the New Zealand Building Code (NZBC) H1 clause.

Table 6 - Criteria set for thermal building insulation's environmental credentials

	Attributes	Red	Black	Green
Insulation – Glasswool	Recycle content	<45%	= 45% / NOT KNOWN	>45%
Insulation polyester	Recycle content	<20%	= 20% / NOT KNOWN	>20%
Insulation wool	Recycle content	<100%	NOT KNOWN	100%
Insulation	Hazardous content	Hazardous	NOT KNOWN	Non-Hazardous
Insulation's Manufacturers	Waste management	No	NOT KNOWN	yes
Insulation	Total VOC's emissions	>0.5mg/m3	= 0.5mg/m3 / NOT KNOWN	<0.5mg/m3
Insulation	Formaldehyde emissions	>0.05ppm	= 0.05ppm / NOT KNOWN	<0.05ppm
Insulation	Energy Management	No	NOT KNOWN	yes

<u>RQ4- How do specific attributes (from eco-labelled products) differ from before the certification period to after the certification period?</u>

The criteria for this research question are applied in a similar way as in the previous research question (RQ3). However, for theRQ4, the comparative analysis will be done between products from the same brand but in different time, instead of the RQ3 that uses eco-labelled and non-eco-labelled products.

3.3.2 Comparative analysis

A theoretical comparison was carried based on the collected data and focusing on the criteria set based on the objectives and research questions postulated in this thesis. The tool used for the data analysis was Microsoft Excel. Tables for each product group were created forming a database.

Chapter 4- Results

This chapter summarizes the results of the research process; it is divided into five subsections: The first three are related to each product group: paints, carpets, and thermal building insulations. The following subsection answers the research questions, and the final subsection provides an overall comparative study.

The first subsection (4.1) is related to paints products; this section starts with the chosen sample (eco-labelled and non-eco-labelled products) followed by its attributes information (performance, retail price and diverse environmental related credentials). The end of this section shows information regarding historical data (before certification period) from eco-labelled paints products.

The ensuing subsections, 4.2 and 4.3, address information for carpets and thermal building insulation respectively. Similarly, these subsections follow the same structure as paints. Subsection 4.4 answers research questions one, two, three and four. The final subsection (4.5) is related to the overall comparative study between the three group products.

All data was collected directly from the products' suppliers, manufacturers or retailers by diverse ways such as websites, emails, phone calls and/or going to meet them in person. The intention was to collect as much accurate data as possible however it was perceived in few occasions that suppliers, manufacturers and retails did not have accurate information.

The full sample of this study was 38 products.

4.1 Paints

4.1.1 Chosen Sample

New Zealand market offers a great variety of paints type; this study focused only on water based interior paints that are applied in non-wet areas and with a level of gloss inside of the range flat, low sheen and Eggshell. This sample of paints offers similar characteristics and provides for a feasible comparative study. In addition to the products characteristics other factors were taken into account when selecting of paints products. Firstly, there are three key manufacturers of eco-labelled paints in New Zealand: Resene, Dulux and Wattyl. These three brands account for 95% of the paint products in the national market.

Furthermore, the selection of the products was also based on the quality and quantity of pertinent information available in chosen brands product data sheets and MSDSs. This last factor was mainly accounted for the non-eco-labelled products.

The following table (7) shows the specific paints products analysed in this study.

Table 7- Analysed paints products

Eco-labelled Products	**Non-eco-labelled Products**
Dulux wash&wear 101 low sheen (ECNZ)	Biopaints - wall paint
Resene space cote low sheen (ECNZ)	Enviropaints Recreated Water Based Low Sheen
ReseneZylone Sheen 0 VOC (ECNZ)	Enviropaints Acrylic Vinyl Low Sheen
Wattyl Interior Design Silk (ECNZ)	Paint Tech Living Shield Low Sheen
Dulux wash&wear 101 flat (ECNZ)	EnviropaintsAcryclic Vinyl Flat
Resene space cote flat (ECNZ)	Paint Tech Ceiling Flat Premium
Resene Ceiling (ECNZ)	
Wattyl Interior Design Eggshell (ECNZ)	

The following subsection show the main attribute values from the selected paint products. Data are displayed in different colours as it was set in the methodology chapter – "Data Analysis" of this research. Values displayed as red were below the criteria, values displayed in black were at the criteria and values displayed in green were above the criteria.

4.1.2 Performance (Coverage)

This study considered coverage (m^2/L) from each of the selected product as an indicator of paint's performance. Data related to paint performances was collected from product data sheets, MSDSs, and verbal or written communication with manufacturers. Table 8 presents the performance from eco-labelled and non-eco-labelled paints. Results show that both groups (eco-labelled and non-eco-labelled paints) have similar average coverage pointing to the insignificant difference products' performances.

Table 8 – Paints' performance

Eco-labelled Products	Coverage- m^2/L (NZD) [1]	Non-eco-labelled Products	Coverage- m^2/L (NZD) [1]
Dulux wash&wear 101 low sheen	16	Biopaints - wall paint	7 to 10
Resene space cote low sheen	11	Enviropaints Recreated Water Based Low Sheen	10 to 12
ReseneZylone Sheen 0 VOC	14 to 16	Enviropaints Acrylic Vinyl Low Sheen	10 to 12
Wattyl Interior Design Silk	16	Paint Tech Living Shield Low Sheen	16
Dulux wash&wear 101 flat	16	Enviropaints Acrylic Vinyl Flat	10 to 12
Resene space cote flat	16	Paint Tech Ceiling Flat Premium	16
Resene Ceiling	11		
Wattyl Interior Design Eggshell	10		

[1] Criteria: above $7m^2/L$ = green

4.1.3 Retail Price

The following values presented in table 9 are related to the New Zealand's market retail price of paint products (per litre). The average price of eco-labelled products is NZ$28.83, ranging from NZ$22.15 to NZ$34.00. The average price of non-eco-labelled products is NZ$16.33, ranging from NZ$11.00 to NZ$33.00. Table 9 illustrates that eco-labelled products are sold with price premium when compared to their non-eco-labelled counterparts.

Table 9 – Paints' retail price

Eco-labelled Products	Retail price (NZ$ per litre)	Non-eco-labelled Products	Retail price (NZ$ per litre)
Dulux wash&wear 101 low sheen	**30 (40%[2] = 12)**	Biopaints - wall paint	**33 (40%[2] = 13,2)**
Resene space cote low sheen	**34 (40%[2] = 13,6)**	Enviropaints Recreated Water Based Low Sheen	**14.5**
Resene Zylone Sheen 0 VOC	**34 (40%[2] = 13,6)**	Enviropaints Acrylic Vinyl Low Sheen	**18.25**
Wattyl Interior Design Silk	**23.00**	Paint Tech Living Shield Low Sheen	**11.00 (cheapest)**
Dulux wash&wear 101 flat	**30 (40%[2] = 12)**	Enviropaints Acrylic Vinyl Flat	**18.25**
Resene space cote flat	**34 (40%[2] = 13,6)**	Paint Tech Ceiling Flat Premium	**14.00**
Resene Ceiling	**22.15**		
Wattyl Interior Design Eggshell	**23.50**		

[2]Criteria: if 40% of each product price is higher than 11 (paint cheapest price), then is highlighted with red, if 40% is exactly 11 then is highlighted with black, otherwise value is highlighted with to green.

4.1.4 Emissions to the environment

Values in Table 10 present VOC's emissions released by paint products. From the eco-labelled products sample, only Resene Space cote range falls close to the minimal requirements for VOC emissions. All others products, in fact most eco-labelled paints emit a very low leves of VOCs. From the 6 non-eco-labelled products, only one product (Biopaints – Wall Paint) does not release any VOCs and is comparable to eco-labelled paints in this sense.

On the other hand, not all "Enviropaints" products are tested for VOC's emissions; and, manufacturer is not able to inform consumers about values of VOC's emissions. Similarly, products from Paint Tech currently do not specify (neither in their products data sheet or MSDS) their VOC's emissions. However, Paint Tech products are verified by the "eurofins" product testing procedures limiting VOC's emissions to the maximum of 30g/L for flat paints and 100g/L for glossy paints. Thus, this product is seen as a product of medium-low VOC's emission. Nevertheless "pain tech living shield low sheen" is categorized as a type of glossy paint (please refer to the Discussion chapter) and can also be classed within a category of products releasing up to 100g/L of VOC's. Such value exceeds this study criteria evaluation and it is considered as a product with high VOC's emissions.

Table 10 – Paints' VOC emission.

Eco-labelled Products	VOC's Emissions (g/l)[3]	Non-eco-labelled Products	VOC's Emissions (g/l)[3]
Dulux wash&wear 101 low sheen	< 5	Biopaints - wall paint	**0**
Resene space cote low sheen	55	Enviropaints Recreated Water Based Low Sheen	NOT KNOWN
ReseneZylone Sheen 0 VOC	**0**	Enviropaints Acrylic Vinyl Low Sheen	NOT KNOWN
Wattyl Interior Design Silk	**< 1**	Paint Tech Living Shield Low Sheen	**100 (refer to discussion chap).**
Dulux wash&wear 101 flat	**<1**	EnviropaintsAcrylic Vinyl Flat	NOT KNOWN
Resene space cote flat	55	Paint Tech Ceiling Flat Premium	**30**
Resene Ceiling	**1**		
Wattyl Interior Design Eggshell	**<1**		

[3]Criteria: values greater than 55g/l are highlighted with red, equal to 55 g/l are black, and less than 55g/l are green.

4.1.5 Recycled content

Table 11 outlines the percentage of recycled materials contained by all paint products. Typically, regular paint products do not have recycled materials in its composition. From the entire sample of paint products, only one has recycled content materials in its formula: "Enviropaints Recreated Water Based Low Sheen". This product is composed from 80% of recycled materials in its formulation process.

Table 11 – Paints' recycled content.

Eco-labelled Products	Recycled content (%)	Non-eco-labelled Products	Recycled content (%)
Dulux wash&wear 101 low sheen	Zero	Biopaints - wall paint	Zero
Resene space cote low sheen	Zero	Enviropaints Recreated Water Based Low Sheen	80
ReseneZylone Sheen 0 VOC	Zero	Enviropaints Acrylic Vinyl Low Sheen	Zero
Wattyl Interior Design Silk	Zero	Paint Tech Living Shield Low Sheen	Zero
Dulux wash&wear 101 flat	Zero	EnviropaintsAcrylic Vinyl Flat	Zero
Resene space cote flat	Zero	Paint Tech Ceiling Flat Premium	Zero
Resene Ceiling	Zero		
Wattyl Interior Design Eggshell	Zero		

4.1.6 Hazardous Substances

The subsequent section summarised by Table 12 provides analysis of the use of hazardous or non-hazardous substances to human and environmental health. Some products offer a classification from the New Zealand Hazardous Substances and New Organisms (NZ HSNO). The majority of the eco-labelled products are described as non-hazardous according to the NZ HSNO regulations; however, there are three products (all from Resene), that are described as hazardous (classification 9.1C - hazardous for the aquatic environment). Please note that, MSDSs of all eco-labelled products' indicate of product's potential to become eco-toxic. For example, Resene informs of its potential eco-toxicity in its MSDS by a statement: "Do not allow entering in the environment", suggesting potential risks of contamination by hazardous substances of the aquatic environment.

Non-eco-labelled products that are considered as non-hazardous are "Biopaints - wall paint" and "Enviropaints Acrylic Vinyl Low Sheen". However, this statement is not attested by the NZ's Hazardous Substances and New Organisms Act 1996 (HSNO) or any other testing group (as the eco-labelled products provide this type of evidence). The information (non-hazardous statement) was gathered via email request for the product "Biopaints – wall paint" and through product data sheet for the product "Enviropaints Acrylic Vinyl Low Sheen".

Non-eco-labelled products that are considered as hazardous by the NZ's HSNO regulations are: "Paint Tech Living Shield Low Sheen" as per hazardous classification 6.3A / 6.4A / 9.1C and "Paint Tech Ceiling Flat premium" (6.3A / 6.4A / 9.1C). In this case, besides the risk of eco-toxicity (9.1C), these products can also be hazardous for the skin (6.3A) and eye (6.4A).

Table 12 – Paints' hazardous substances

Eco-labelled Products	**Hazardous Substances**	**HSNO Classification[3]**	**Non-eco-labelled Products**	**Hazardous Substances**	**HSNO Classification[3]**
Dulux wash&wear 101 low sheen	**Non Hazardous**		Biopaints - wall paint	**Non Hazardous (do not say according to HSNO)**	
Resene space cote low sheen	Hazardous	9.1C	Enviropaints Recreated Water Based	NOT KNOWN	
ReseneZylone Sheen 0 VOC	Hazardous	9.1C	Enviropaints Acrylic Vinyl Low Sheen	**Non-toxic, lead and heavy metal free (dry film)**	
Wattyl Interior Design Silk	**Non Hazardous**		Paint Tech Living Shield Low Sheen	Hazardous	6.3A / 6.4A / 9.1C
Dulux wash&wear 101 flat (ECNZ)	**Non Hazardous**		Enviropaints Acryclic Vinyl Flat	NOT KNOWN	
Resene space cote flat	**Hazardous**	9.1C	Paint Tech Ceiling Flat Premium	**Hazardous**	6.3A / 6.4A / 9.1C
Resene Ceiling	**Non Hazardous**				
Wattyl Interior Design Eggshell (ECNZ)	**Non Hazardous**				

[3]Category 9.1C – "substances that are harmful in the aquatic environment /Category 6.3A – "substances that are irritating to the skin /Category 6.4A – "substances that are irritating to the eye

4.1.7 Waste Management

Table 13 outlines information regarding the presence of waste management procedures during product manufacturing. The majority of eco-labelled paints are produced with waste management practices present on site (information gathered through data sheets or MSDS). The typical waste management project focus at zero waste practices or practices with aim to minimize waste generation. On the other hand, only half of the non-eco-labelled products inform the consumer about good waste management procedures – increasing the possibility of reduced attention to waste minimisation in non-eco-label paint product sample.

Table 13 – Paints' waste management procedures

Eco-labelled Products	Waste Management procedures	Non-eco-labelled Products	Waste Management procedures
Dulux wash&wear 101 low sheen	**Every endeavour is made to minimise the quality and quantity of waste generation**	Biopaints - wall paint	NOT KNOWN
Resene space cote low sheen	**reuse, reduce, recycle projects for the unwanted paints**	Enviropaints Recreated Water Based Low Sheen	**zero waste projects**
ReseneZylone Sheen 0 VOC	**reuse, reduce, recycle projects for the unwanted paints**	Enviropaints Acrylic Vinyl Low Sheen	**zero waste projects**
Wattyl Interior Design Silk	NOT KNOWN	Paint Tech Living Shield Low Sheen	NOT KNOWN
Dulux wash&wear 101 flat	**Every endeavour is made to minimise the quality and quantity of waste generation**	EnviropaintsAcrylic Vinyl Flat	**zero waste projects**
Resene space cote flat	**reuse, reduce, recycle projects for the unwanted paints**	Paint Tech Ceiling Flat Premium	NOT KNOWN
Resene Ceiling	**reuse, reduce, recycle projects for the unwanted paints**		
Wattyl Interior Design Eggshell	NOT KNOWN		

4.1.8 Eco-toxicity

Table 14 presents information related to the potential to eco-toxicity that paints products can cause, after its disposal. Again, eco-toxicity is seen through the lenses of potential eco-toxicity to waterways if paints are incorrectly disposed. All brands products but one (Enviropaints) provide such information. (Please note; there are no data sheets or MSDS available for most of Enviropaints products).

Table 14 – Paints' potential to eco-toxicity

Eco-labelled Products	Potential to eco-toxicity	Non-eco-labelled Products	Potential to eco-toxicity
Dulux wash&wear 101 low sheen (ECNZ)	Avoid disposal in waterways	Biopaints - wall paint	Avoid disposal in waterways
Resene space cote low sheen (ECNZ)	Do not allowed to enter the	Enviropaints Recreated Water Based Low Sheen	NOT KNOWN
ReseneZylone Sheen 0 VOC (ECNZ)	Do not allowed to enter the environment	Enviropaints Acrylic Vinyl Low Sheen	NOT KNOWN
Wattyl Interior Design Silk (ECNZ)	Prevent disposal in the waterways	Paint Tech Living Shield Low Sheen	Do not allowed to enter the environment
Dulux wash&wear 101 flat (ECNZ)	Avoid disposal in waterways	Enviropaints Acrylic Vinyl Flat	NOT KNOWN
Resene space cote flat (ECNZ)	Do not allowed to enter the environment	Paint Tech Ceiling Flat Premium	Do not allowed to enter the environment
Resene Ceiling (ECNZ)	Do not allowed to enter the environment		
Wattyl Interior Design Eggshell (ECNZ)	Prevent disposal in the waterways		

4.1.9 Overall paints attributes

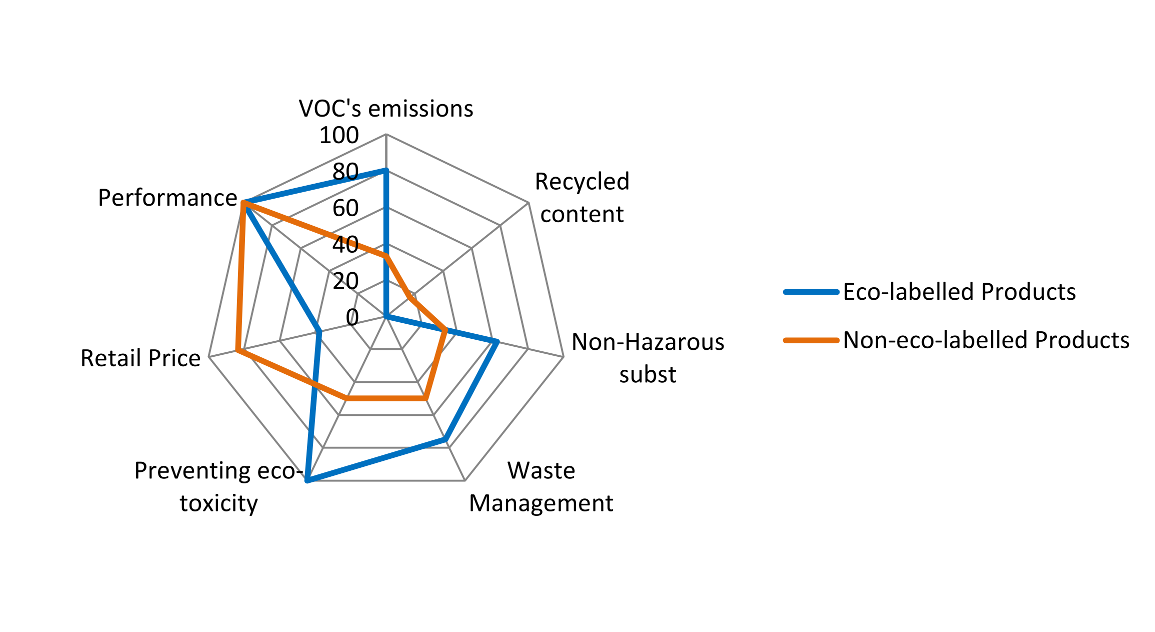

Figure 7 – Comparative analysis of paints' attributes - Percentage of selected products appearing above given criteria set.

Figure 7 presents a comparative analysis that includes all the main attributes for paints and depicts the situation between eco-labelled and non-eco-labelled products. Results show that eco-labelled products provide more specific information in respect to VOC's emissions, waste management, hazardous substances and preventing eco-toxicity. Non-eco-labelled products, however, signal lower retail prices and offer products that contain recycled materials.

4.1.10 Historical Information

As mentioned earlier, this study also strived to identify trends in stringency required by certification schemes. Thus, eco-labelled paints were assessed against criteria required in the year of product's first certification and then these products were compared to pre-certification product's attributes to assess whether any changes were stipulated by the process of certification.

Resene's products were certified in 1996, Dulux in 2005 and Wattyl in 2009. However, Dulux and Resene manufacturers were not able to generate pre-certification product attributes. Only Wattyl delivered sufficient historical information for this comparative analysis.

Thus Tables 15 and 16 show main attributes related to the two Wattyl paint products: "Interior Silk" and "Interior Eggshell". These values are from before and after certification periods. Tables 15 and 16 also inform that paints products' main attributes had few changes over the time. The key paint attribute most highlighted in the historical information is the VOC's emissions; this value dropped from 76 to <1g/L and from 72 to <1g/L over-time for silk and eggshell interiors, respectively.

Others attributes had only minor changes; as for instance: “hazardous identification” and “performance”.At present, Wattyl products are presented as non-hazardous product; however, before the certification period information about its hazardous substances could not be collated. The last two attributes: “waste management” and “eco-toxicity” suggest no changes between before and after the certification process.

Table 15 – Historical information from Wattyl products (interior Silk)

Attributes	Before Certification (2008)	Current (2013)
Performance	14-16 m^2/L	16m^2/L
VOC’s emissions	76g/l	<1g /l
Hazardous identification	NOT KNOWN	Non-hazardous
Waste Management	NOT KNOWN	NOT KNOWN
Eco-toxicity	Prevent	Prevent

Table 16 – Historical information from Wattyl products (interior Eggshell)

Attributes	Before Certification (2008)	Current (2013)
Performance	14-16 m^2/L	16m^2/L
VOC’s emissions	72g/l	<1g /l
Hazardous identification	NOT KNOWN	Non-hazardous
Waste Management	NOT KNOWN	NOT KNOWN
Eco-toxicity	Prevent	Prevent

4.2 Carpets

4.2.1 Chosen Sample

Similar to paints, the rationale for carpets selection was primarily guided by the quantity and quality of available information displayed by manufacturers', suppliers' and retailers' websites. Fifteen synthetic carpet tiles for the commercial use were selected to be analysed in this study. These are presented in Table 17.

Table 17 – Analysed carpets products.

Eco-labelled Products (multiple attributes)	**Non-eco-labelled Products / Limited Certified Products (single attributes)**
Modulyss ECO 100C (ECNZ and others)	Ecofloor – Toli Corporation – GA 8800EM (CRI)[4]
Modulyss ECO 100L (ECNZ and others)	Carpet Inter – In Transit (CRI)[4]
Irvine – Point of View (ECNZ)	Durkan's – Watermark 36 (CRI)[4]
Belgotex – Baltimore (ECNZ)	Project floors – Pro-tile first Class (No Label)
Modulyss – First (several)	Carpet Mill – Verona (No Label)
Feltex Cosmos (CIAL – ECS level 4)	
Interface – Cosmos (Green Tag, ACCS)	
Godfrey Hirst – Accessory (ACCS and CRI)	
Godfrey Hirst – Base Affect (ACCS and CRI)	
Godfrey Hirst – Curriculum (ACCS and CRI)	

[4] CRI - A single attribute certification (which check only carpet's emissions to the environment) and for this reason, the product is considered as "limited certified" for this research.

Such as in paints section; the subsequent tables show the main attributes values and characteristics for the selected carpets products.

4.2.2 Performance (durability)

This work considers carpets' durability/warranty as the performance of the product. Table 18 shows that all eco-labelled products inform consumers about product's warranty. In contrast, non-eco-labelled products do not inform about the warranty period for all of the analysed products. Warranty criteria seen as desirable are defined as 15+years (for more information on criteria setting for carpets see Methodology chapter). Results show that 60% of the products that inform of a warranty period, fall within this desirable category.

Table 18 – Carpets' performance

Eco-labelled Products	**Warranty**	**Non-eco-labelled Products/ Limited Certified Products**	**Warranty**
Modulyss - Heritage Carpets / ECO 100 C	**15 years limited warranty**	Project floors / Pro-Tile first class	**15 years limited warranty**
Modulyss - Heritage Carpets / ECO 100 L	**15 years limited warranty**	Carpet Mill / Verona	**10 years manufacturer defect**
Irvine / Point of View	**Lifetime Warranties with conditions**	Ecofloor - Toli Corporation / GA - 8800EM	**15 years limited warranty**
Belgotex Baltimore	**15 years limited warranty**	Carpet Inter / In Transit	NOT KNOWN
Modulyss - Heritage Carpets / First	**15 years limited warranty**	Durkan's / Watermark 36	**15 years limited warranty**
Feltex/ Cosmos	**12 years limited warranty**		
Interface / Cosmos	**15 years limited warranty**		
Godfrey Hirst / Accessory	**15 years limited warranty**		
Godfrey Hirst / Base Affect	**12 years limited warranty**		
Godfrey Hirst / Curriculum	**15 years limited warranty**		

4.2.3 Retail Price

Retail price of synthetic carpets tiles are given in NZ$ and per square metre of carpet. Table 19 indicates that all carpet products fall in the same range of retail price category. For implications on product value proposition, refer to the Discussion chapter of this thesis.

Table 19 – Carpets' retail price.

Eco-labelled Products	**Retail Price per m^2 (NZ$)[5]**	**Non-eco-labelled Products/ Limited Certified Products**	**Retail Price per m^2 (NZ$)[5]**
Modulyss - Heritage Carpets / ECO 100 C	**65**	Project floors / Pro-Tile first class	**55**
Modulyss - Heritage Carpets / ECO 100 L	**50**	Carpet Mill / Verona	**69**
Irvine / Point of View	**83**	Ecofloor - Toli Corporation / GA - 8800EM	**62**
Belgotex Baltimore	Not tile. It is broadloom (won't be able to compare prices)	Carpet Inter / In Transit	**39 (cheapest)**
Modulyss - Heritage Carpets / First	**45**	Durkan's / Watermark 36	**90 (40% = 36)**
Feltex/ Cosmos	**55**		
Interface / Cosmos	**85**		
Godfrey Hirst / Accessory	**55-79**		
Godfrey Hirst / Base Affect	**55-79**		
Godfrey Hirst / Curriculum	**55-79**		

[5] Criteria: if 40% of each product price is higher than 39; than = to read, if it is 39 = black, otherwise = green.

4.2.4 Recycled Content

The following three tables 20, 21 and 22 relate the percentages of recycled materials that each carpet products might content. Recycled content in carpets differs in two key components: face fibre and backing. Most of the manufacturers provide information for both of these parts. Hence, these values are separated in two tables. Besides this, an overall recycled content value is also provided by a few manufacturers.

Results indicate that the vast majority of the non-eco-labelled products do not inform about the content of recycled materials of their products. On the other hand, most eco-labelled products beyond informing consumers about its recycled content materials, they also include a high level of recycled materials for face fibre, backing, as well as for their overall composition.

Table 20 – Carpets' recycled content (from the face fibre)

Eco-labelled Products	**Recycled content (%)[6]**	**Non-eco-labelled Products/ Limited**	**Recycled content (%)[6]**
Modulyss - Heritage Carpets / ECO 100 C	**100% (post-consumer and post-industrial**	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	**100% (post-consumer and post-industrial**	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	**25% recycled**	Ecofloor - Toli Corporation / GA -	**100%**
Belgotex Baltimore	**NOT KNOWN (but must be above 10%)**	Carpet Inter / In Transit	NOT KNOWN
Modulyss - Heritage Carpets / First	10%	Durkan's / Watermark 36	NOT KNOWN
Feltex/ Cosmos	NOT KNOWN		
Interface / Cosmos	NOT KNOWN		
Godfrey Hirst / Accessory	NOT KNOWN		
Godfrey Hirst / Base Affect	NOT KNOWN		
Godfrey Hirst / Curriculum	NOT KNOWN		

[6]The criteria for synthetic carpets recycled content from the face fibre is a minimum of 10%.

Table 21 – Carpets' recycled content (from the backing)

Eco-labelled Products	Recycled content (%)[7]	Non-eco-labelled Products/ Limited Certified Products	Recycled content (%)[7]
Modulyss - Heritage Carpets / ECO 100 C	**100% post-consumer recycled PET**	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	**100% post-consumer recycled PET**	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	**85% post-consumer**	Ecofloor - Toli Corporation / GA - 8800EM	NOT KNOWN
Belgotex Baltimore	**NOT KNOWN (but must be above 20%)**	Carpet Inter / In Transit	**85% post-consumer waste**
Modulyss - Heritage Carpets / First	**100% post-consumer recycled PET**	Durkan's / Watermark 36	NOT KNOWN
Feltex/ Cosmos	**60%**		
Interface / Cosmos	NOT KNOWN		
Godfrey Hirst / Accessory	**Minimum of 60%**		
Godfrey Hirst / Base Affect	**Minimum of 60%**		
Godfrey Hirst / Curriculum	**Minimum of 60%**		

[7]The criteria for synthetic carpets recycled content from the backing is a minimum of 20%.

Table 22 – Carpets' overall recycled content

Eco-labelled Products	Recycled content (%)[8]	Non-eco-labelled Products/ Limited Certified Products	Recycled content (%)[8]
Modulyss - Heritage Carpets / ECO 100 C	24%	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	20%	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	NOT KNOWN	Ecofloor - ToliCorporation / GA - 8800EM	NOT KNOWN
Belgotex Baltimore	NOT KNOWN	Carpet Inter / In Transit	NOT KNOWN
Modulyss - Heritage Carpets / First	9%	Durkan's / Watermark 36	NOT KNOWN
Feltex/ Cosmos	40%		
Interface / Cosmos	from 64% to75%		
Godfrey Hirst / Accessory	Minimum of 40%		
Godfrey Hirst / Base Affect	Minimum of 40%		
Godfrey Hirst / Curriculum	Minimum of 40%		

[8]The criteria for synthetic carpets overall recycled content is a minimum of 15%.

4.2.5 Waste Management

This section provides information in respect to the presence of waste management procedures; more specifically Take Back programmes and/or waste minimization projects during the manufacturing phase.

Table 23 shows that the majority of carpets products provide information related to Take Back programmes. Two non-eco-labelled products, however, do not inform about this kind of programme. The only three non-eco-labelled products that provide information about Take Back programmes are "limited certified"- holding CRI accreditation. However, this eco-label does not require parameters concerning waste management; for this reason, they are considered non-labelled products (for waste management attribute).

Table 24 demonstrate that eco-labelled products exceed non-eco-labelled products regarding consumer's information about waste minimization.

Table 23 – Carpets' Take Back programme

Eco-labelled Products	**Take Back programme**	**Non-eco-labelled Products/ Limited**	**Take Back programme**
Modulyss - Heritage Carpets / ECO 100 C	YES	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	YES	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	YES	Ecofloor - Toli Corporation / GA -	YES
Belgotex Baltimore	YES (because ECNZ req.) the data sheet)	Carpet Inter / In Transit	YES
Modulyss - Heritage Carpets / First	YES	Durkan's / Watermark 36	YES
Feltex/ Cosmos	YES		
Interface / Cosmos	YES		
Godfrey Hirst / Accessory	YES		
Godfrey Hirst / Base Affect	YES		
Godfrey Hirst / Curriculum	YES		

Table 24 – Carpets' waste minimization procedures

Eco-labelled Products	Waste Minimization	Non-eco-labelled Products/ Limited	Waste Minimization
Modulyss - Heritage Carpets / ECO 100 C	**3-4% of total production**	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	**3-4% of total production**	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	**NOT KNOWN (but should be less 10% of total**	Ecofloor - Toli Corporation / GA - 8800EM	**decreased 40% from 2000**
Belgotex Baltimore	**NOT KNOWN (but should be less 10% of total**	Carpet Inter / In Transit	**decreased 40% from 2000**
Modulyss - Heritage Carpets / First	**3-4% of total production**	Durkan's / Watermark 36	NOT KNOWN
Feltex/ Cosmos	NOT KNOWN		
Interface / Cosmos	NOT KNOWN		
Godfrey Hirst / Accessory	**Yes, but no percentage**		
Godfrey Hirst / Base Affect	**Yes, but no percentage**		
Godfrey Hirst / Curriculum	**Yes, but no percentage**		

4.2.6 Emissions to the environment

This section shows information related to VOC's emissions, which represents a relevant component of carpets' production impacting negatively on the environment.

Table 25 depicts that the vast majority of the eco-labelled products informs of low VOC's emissions. The products that were before classified as "limited certified", in this case are not considered limited because the only attribute that their label requires is related to the emission to the environment. The two products that do not possess any label, also do not inform about VOC emissions.

Table 25 – Carpets' VOC emission

Eco-labelled Products	VOC's Emissions	Non-eco-labelled Products	VOC's Emissions
Modulyss - Heritage Carpets / ECO 100 C	**< 0.5 mg/m3/hr (24 hours)**	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	**< 0.5 mg/m3/hr (24 hours)**	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	**< 0.5 mg/m3/hr (24 hours)**		
Belgotex Baltimore	**< 0.5 mg/m3/hr (24 hours)**		
Modulyss - Heritage Carpets / First	**< 0.5 mg/m3/hr (24 hours)**		
Feltex/ Cosmos	**< 0.5 mg/m3/hr (24 hours)**		
Interface / Cosmos	**< 0.5 mg/m3/hr (24 hours)**		
Ecofloor - Toli Corporation / GA - 8800EM	**< 0.5 mg/m3/hr (24 hours)**		
Carpet Inter / In Transit	NOT KNOWN		
Durkan's / Watermark 36	**< 0.5 mg/m3/hr (24 hours)**		
Godfrey Hirst / Accessory	**< 0.5 mg/m3/hr (24 hours)**		
Godfrey Hirst / Base Affect	**< 0.5 mg/m3/hr (24 hours)**		
Godfrey Hirst / Curriculum	**< 0.5 mg/m3/hr (24 hours)**		

4.2.7 Energy Management

Statements on Table 26 provide energy management measures from the selected products; these measures are mostly related to sources of renewable/green energy and minimization of the energy use and efficiency.

Table 26 shows that eco-labelled and non-eco-labelled products do not change in respect to the energy management procedure. Exactly half of both samples inform of energy saving procedures present on manufacturing site.

Table 26 – Carpets' energy management procedures

Eco-labelled Products	Energy Management	Non-eco-labelled Products	Energy Management
Modulyss - Heritage Carpets / ECO 100 C	**14% own solar panels and 86% is 100% green energy purchase**	Project floors / Pro-Tile first class	NOT KNOWN
Modulyss - Heritage Carpets / ECO 100 L	**14% own solar panels and 86% is 100% green energy purchase**	Carpet Mill / Verona	NOT KNOWN
Irvine / Point of View	**Currently buy enough green power to meet 100% of our total purchased**	Ecofloor - Toli Corporation / GA - 8800EM	**Energy efficiency/ reduction in energy consumption/ making use of natural energy**
Belgotex Baltimore	**energy reduction**	Carpet Inter / In Transit	NOT KNOWN
Modulyss - Heritage Carpets / First	**14% own solar panels and 86% is 100% green energy purchase**	Durkan's / Watermark 36	**Reduce the total energy consumption (25%) by the year 2020**
Feltex/ Cosmos	NOT KNOWN		
Interface / Cosmos	NOT KNOWN		
Godfrey Hirst / Accessory	NOT KNOWN		
Godfrey Hirst / Base Affect	NOT KNOWN		
Godfrey Hirst / Curriculum	NOT KNOWN		

4.2.8 Overall Carpets attributes.

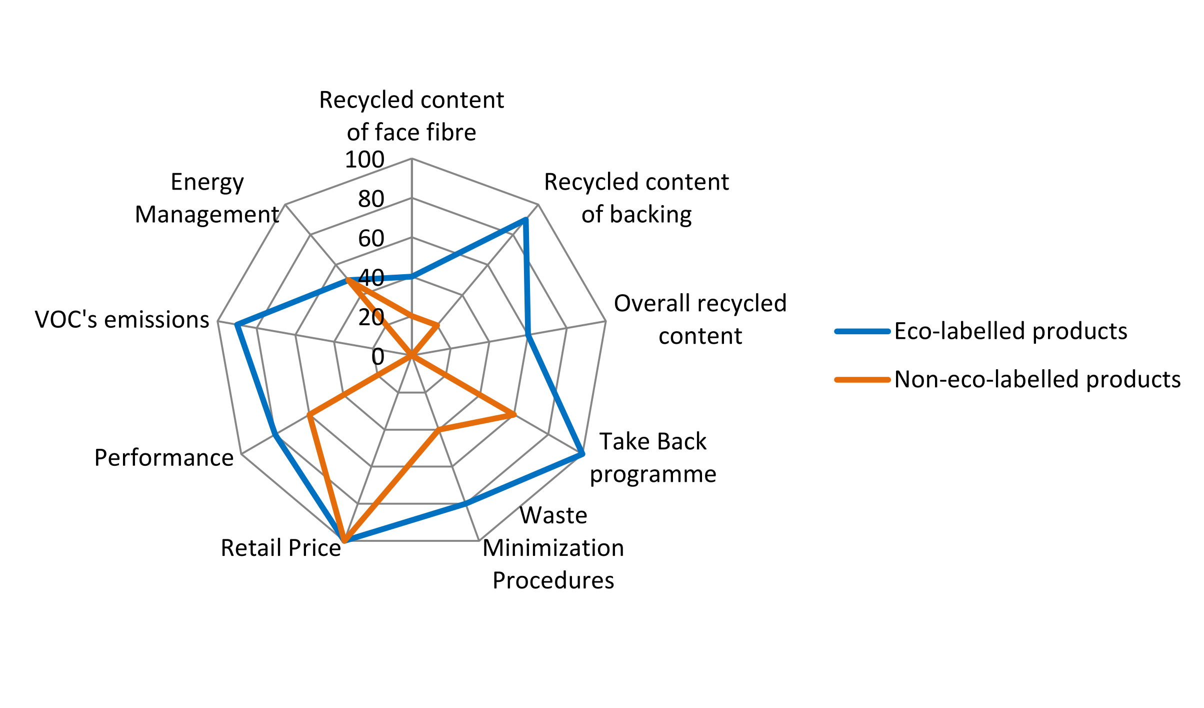

Figure 8 – Comparative analysis of carpets' attributes - Percentage of selected products appearing above given criteria set.

Figure 8 provides a comparative scenario for synthetic tile carpets and includes all studied attributes and their relationship between eco-labelled and non-eco-labelled products. Results show that eco-labelled products provide more detailed information, regarding most attributes when compared to non-eco-labelled products. Specifically, greater detail is available for overall recycled content, recycled content of face fibre, recycled content of backing, Take Back programmes, waste minimization, performance and VOC's emissions. Whereas the retail price and energy management are comparable to non-eco-labelled products. For implications of these findings refer to the Discussion chapter.

4.2.9 Historical Information

Similarly to paints products, to be able to get historical information from carpets, the date (year) that eco-labelled products (from ECNZ) received their certification was accessed. Carpets from Modulyss, Irvine and Belgotex were verified for this historical analysis and their respectively certification years were: 2012, 2008 and 2012.

Modullyss and Irvine could not provide data sheets from the period before their certification either by the wayback machine, phone calls or emails to manufacturers, suppliers and retailers.

A data sheet from 2010 was retrieved from Belgotex carpet, and no changes from that date to current time was attested; the previous data sheet showed same values and statements from the current one.

4.3 Thermal building insulation

4.3.1 Chosen Sample

Thermal building insulation products were selected through a different approach compared to paints and synthetic carpets. The main reason for the differences to sample selection is attributed to the large variety in types of insulation's raw materials. Besides, the New Zealand market has just a few manufacturers from each type of product. For instance, more than eleven different manufacturers for synthetic carpets were found in the New Zealand market, whereas only four manufacturers for polyester insulations and five manufacturers for glasswool insulations is present in this country market.

For these reasons, there were fewer products to be selected comparing to the previous studied products. Again products were selected based on characteristics that allow for later comparability: attributes-related characteristics, installation procedures, durability requirements and R-value (thermal resistance). In addition, products needed to be available in the New Zealand market.

Resulting sample consisted of products made from three different raw materials: Glasswool (Fibreglass), Polyester and Wool. Some products only contained one type of raw material, others a mix of them. The selected products are blankets or biscuits type and insulation installed in the ceilings. The average R-value considered in this research is 3.6, which is the most common for the Christchurch region.

Nine manufacturers were selected to have their products analysed for this study. Thermal building insulation attributes, from different products but same manufacturer, do not change such as paints and carpets attributes change; for this reason one product was chosen for each manufacturer. Table 27 illustrates these products names.

Table 27 – Analysed thermal building insulations products

Eco-labelled Products	**Non-eco-labelled Products**
Tasman – Pink Batts classic ceiling (ECNZ and others)	Polygold Premium Thermal Insulation
CSR Bradford – Gold Ceiling (ECNZ)	Premier A Grade Insulation
Autex – Green Stuf Ceiling (ECNZ)	Eco-insulation – Recycled Ecofleece Ceiling
Insulpro – Novatherm Ceiling (ECNZ)	Terra Lana – Ceiling
Kanauf – Earthwoll Ceiling blanket (Blue Angel and others[5])	

[5]Blue Angel eco-label does not check “Recycle Content”, “Energy Management” and “Waste Management”, for this attributes the Kanauf’s insulation will be considered as non-eco-labelled, for the others attributes: “Total VOC’s emissions”, Formaldehyde emissions”, “Hazardous Substances”, “Performance” and “Retail price” it will be considered as eco-labelled.

Since thermal building insulation products diverge regarding the type of raw material components, this study divided the selected products in two different groups (with similar products characteristics), to make the comparative study feasible for this research.

Group one:

Tasman Pink Batts – “Flexible glasswool insulation”

CSR Bradford Gold – “Compressible glasswool insulation”

Kanauf Earthwoll – “Inorganic glass fibres”

Polygold premium – “Glasswool and Phenol”

Premier A Grade Insulation – “Glasswool insulation”

Group two:

Eco-insulation recycled Ecofleece – “Wool (60%) and polyester (40%)”

Terra Lana – “Mixture from wool (recycled fibre and new sheep’s wool) and polyester (30%)”

Autex Green Stuf – “100% polyester”

Insulpro Novatherm – “Polyester fibres”

Following the same standard as paints and synthetic carpets; the subsequent tables show the main specific attributes values for thermal building insulation.

4.3.2 Performance (durability)

This work considered thermal building insulation performance as the durability/warranty of the product. Tables 28 and 29 demonstrate that all thermal building insulation products, eco-labelled and non-eco-labelled, comply with the New Zealand Building Code (NZBC) (clause B2 durability) and consequently this study criterion.

The New Zealand's Ministry of Business, Innovation & Employment website defines that "The Building Code requires 50 year durability for building elements that are difficult to access or replace, or where failure of the building element to comply would go undetected".

<u>Glasswool (Group one)</u>

Table 28 – Thermal building insulations' performance (glasswool)

Eco-labelled Products	Performance	Non-eco-labelled Products	Performance
Tasman - Pink batts classic ceiling	50 years	Polygold Premium Thermal Insulation - Ceiling Biscuits	50 years
CSR Bradford - Gold Ceiling	50 years	Premier A Grade Insulation - Ceiling	50 years
Kanauf - Earthwoll ceiling blanket	50 years		

Polyester/ Wool (Group two)

Table 29 – Thermal building insulations' performance (polyester/wool)

Eco-labelled Products	Performance	Non-eco-labelled Products	Performance
Autex - GreenStuf Ceiling	50 years	Eco insulation - Recycled Ecofleece® ceiling	50 years
Insulpro - Novatherm Ceiling	50 years	Terra Lana - Ceiling	50 years

4.3.3 Retail Price

Such as the performance trend, tables 30 and 31 show that all the analysed products (eco-labelled and non-eco-labelled) are in the same range regarding retail prices criteria set (see RQ2).

Glasswool (Group one)

Table 30 – Thermal building insulations' retail price (glasswool)

Eco-labelled Products	Retail Price per m^2(NZD)	Non-eco-labelled Products	Retail Price per m^2(NZD)
Tasman - Pink batts classic ceiling	15.13	Polygold Premium Thermal Insulation - Ceiling Biscuits	7.95
CSR Bradford - Gold Ceiling	14.48	Premier A Grade Insulation - Ceiling	9.4
Kanauf - Earthwoll ceiling blanket	10.11		

Polyester/Wool (Group two)

Table 31 – Thermal building insulations' retail price (polyester/wool)

Eco-labelled Products	Retail Price per m^2	Non-eco-labelled Products	Retail Price per m^2
Autex - GreenStuf Ceiling	20.63	Eco insulation - Recycled Ecofleece® ceiling	22
Insulpro - Novatherm Ceiling	23	Terra Lana - Ceiling	21.38

4.3.4 Recycled Content

Values on Table 32 are related to the percentage of recycled materials that each thermal building insulation product contains. The same table shows that the full sample of glasswool products consist of a great amount of recycled materials components. Particularly, this type of insulation already has a propensity of having great amount of recycled materials in its composition.

Table 33 demonstrates that half of the sample does not inform about its recycled content materials; 50% of eco-labelled and 50% of non-eco-labelled products provides "NOT KNOWN" answers.

Glasswool (Group one)

Table 32 – Thermal building insulations' recycled content (glasswool)

Eco-labelled Products	Recycled Content (%)[6]	Non-eco-labelled Products	Recycled Content(%)[6]
Tasman - Pink batts classic ceiling	Up to 80%	Polygold Premium Thermal Insulation - Ceiling Biscuits	100%
CSR Bradford - Gold Ceiling	Up to 65%	Premier A Grade Insulation - Ceiling	70-80%
		Kanauf - Earthwoll ceiling blanket	Up to 80%

[6]Qualitative criteria for glasswool insulation is a minimum 45% of recycled glass

Polyester/ Wool (Group two)

Table 33 – Thermal building insulations' recycled content (polyester /wool)

Eco-labelled Products	Recycled Content(%)[7]	Non-eco-labelled Products	Recycled Content(%)[7]
Autex - GreenStuf Ceiling	45% Polyester	Eco insulation - Recycled Ecofleece® ceiling	100% recycled wool[8]
Insulpro - Novatherm Ceiling	Minimum 20%	Terra Lana - Ceiling	NOT KNOWN

[7] Qualitative criteria minimum 20% for polyester insulations and 100% for wool insulation.

[8] Composition of the Recycled Ecofleece® ceiling is 60% wool and 40% polyester, hence for this scenario (recycled content), this insulation will be considered as wool insulation and follow its criteria.

4.3.5 Hazardous Substances

The following findings are related to the hazardous classification, associated to the New Zealand human and environmental health.

Results demonstrate that none of the thermal building insulation products possess hazardous substances. Most of the thermal building insulation available in the New Zealand market complies with several of the clauses from the NZBC, this case: F2 clause – "hazardous building materials".

<u>Glasswool (Group one)</u>

Table 34 – Thermal building insulations' hazardous substances (glasswool)

Eco-labelled Products	Hazardous Substances	Non-eco-labelled Products	Hazardous Substances
Tasman - Pink batts classic ceiling	No-Hazardous Substances	Polygold Premium Thermal Insulation - Ceiling Biscuits	No-Hazardous Substances
CSR Bradford - Gold Ceiling	No-Hazardous Substances	Premier A Grade Insulation - Ceiling	No-Hazardous Substances
Kanauf - Earthwoll ceiling blanket	No-Hazardous Substances		

<u>Polyester/ Wool (Group two)</u>

Table 35 – Thermal building insulations' hazardous substances (polyester/wool)

Eco-labelled Products	Hazardous Substances	Non-eco-Labelled Products	Hazardous Substances
Autex - GreenStuf Ceiling	No-Hazardous Substances	Eco insulation - Recycled Ecofleece® ceiling	No-Hazardous Substances
Insulpro - Novatherm Ceiling	No-Hazardous Substances	Terra Lana – Ceiling	No-Hazardous Substances

4.3.6 Emissions to the environment

Tables 36,37,38 and 39 are related to emissions that thermal building insulation releases, major emissions from these products are formaldehyde and also total VOC's.

Tables 36 and 37 show that most of the eco-labelled products release a very low level of formaldehyde emissions and only one eco-labelled product does not inform of its emission. The opposite scenario is related to the non-eco-labelled products, where only one manufacturer (Terra Lana) informs to the consumer a low level of formaldehyde emission.

Tables 38 and 39 show that: three from five eco-labelled products inform of a low total VOC's emissions and none of the non-eco-labelled products inform consumer about these emissions.

4.3.6..1 Formaldehyde

Glasswool (Group one)

Table 36 – Thermal building insulations' formaldehyde emission (glasswool)

Eco-labelled Products	Formaldehyde	Non-eco-labelled Products	Formaldehyde
Tasman - Pink batts classic ceiling	**≤ 0.05ppm (greenguard req.)**	Polygold Premium Thermal Insulation - Ceiling Biscuits	NOT KNOWN
CSR Bradford - Gold Ceiling	NOT KNOWN	Premier A Grade Insulation – Ceiling	NOT KNOWN
Kanauf - Earthwoll ceiling blanket	**FREE**		

Polyester/ Wool (Group two)

Table 37 – Thermal building insulations' formaldehyde emission (polyester/wool)

Eco-labelled Products	Formaldehyde	Non-eco-labelled Products	Formaldehyde
Autex - GreenStuf Ceiling	**FREE**	Eco insulation - Recycled Ecofleece® ceiling	NOT KNOWN
Insulpro - Novatherm Ceiling	**< 0.009mg/m3**	Terra Lana – Ceiling	**It traps formaldehyde**

4.3.6..2 Total VOC's

Glasswool (Group one)

Table 38 – Thermal building insulations' total VOC emission (glasswool)

Eco-labelled Products	Total VOC's	Non-eco-labelled Products	Total VOC's
Tasman - Pink batts classic ceiling	**≤ 0.05 mg/m3 (greenguard req.)**	Polygold Premium Thermal Insulation - Ceiling Biscuits	NOT KNOWN
CSR Bradford - Gold Ceiling	**<1%**	Premier A Grade Insulation – Ceiling	NOT KNOWN
Kanauf - Earthwoll ceiling blanket	NOT KNOWN		

Polyester/ Wool (Group two)

Table 39 – Thermal building insulations' total VOC emission (polyester/ wool)

Eco-labelled Products	Total VOC's	Non-eco-labelled Products	Total VOC's
Autex - GreenStuf Ceiling	NOT KNOWN	Eco insulation - Recycled Ecofleece® ceiling	NOT KNOWN
Insulpro - Novatherm Ceiling	< 0.005 mg/m3	Terra Lana – Ceiling	NOT KNOWN

4.3.7 Waste Management

Tables 40 and 41 show the presence of waste management procedures during products' manufacturing processes. Values indicate if product manufacturers aim towards zero waste initiatives (or similar). Results show that eco-labelled products tend to inform more of processes in respect to the environmental friendly waste management compared to the non-eco-labelled products.

Glasswool (Group one)

Table 40 – Thermal building insulations' waste management procedures (glasswool)

Eco-Labelled Products	Waste Management	Non-Eco-Labelled Products	Waste Management
Tasman - Pink batts classic ceiling	yes	Polygold Premium Thermal Insulation - Ceiling Biscuits	NOT KNOWN
CSR Bradford - Gold Ceiling	NOT KNOWN	Premier A Grade Insulation – Ceiling	NOT KNOWN
		Kanauf - Earthwoll ceiling blanket	it is 100% recyclable

Polyester/ Wool (Group two)

Table 41 – Thermal building insulations' waste management procedures (polyester/wool)

Eco-labelled Products	Waste Management	Non-eco-labelled Products	Waste Management
Autex - GreenStuf Ceiling	yes	Eco insulation - Recycled Ecofleece® ceiling	NOT KNOWN
Insulpro - Novatherm Ceiling	yes	Terra Lana - Ceiling	NOT KNOWN

4.3.8 Energy Management

The following section is related to the energy management processes related to the thermal building insulations. In particular, this section reveals whether a product complies with the H1 clause from NZBC or not. Tables 42 and 43 demonstrate that all analysed products comply with the NZBC clause H1 (energy efficiency provisions). Hence all products are considered to have environmental friendly energy management procedures.

Glasswool (Group one)

Table 42 – Thermal building insulations' energy management procedures (glasswool)

Eco-labelled Products	Energy Management	Non- eco-labelled Products	Energy Management
Tasman - Pink batts classic ceiling	yes	Polygold Premium Thermal Insulation - Ceiling Biscuits	Yes
CSR Bradford - Gold Ceiling	yes	Premier A Grade Insulation – Ceiling	yes
		Kanauf - Earthwoll ceiling blanket	yes

Polyester/ Wool (Group two)

Table 43 – Thermal building insulations' energy management procedures (polyester/ wool)

Eco-labelled Products	Energy Management	Non-eco-labelled Products	Energy Management
Autex - GreenStuf Ceiling	yes	Eco insulation - Recycled Ecofleece® ceiling	yes
Insulpro - Novatherm Ceiling	yes	Terra Lana – Ceiling	yes

4.3.9 Overall Thermal Building Insulation attributes.

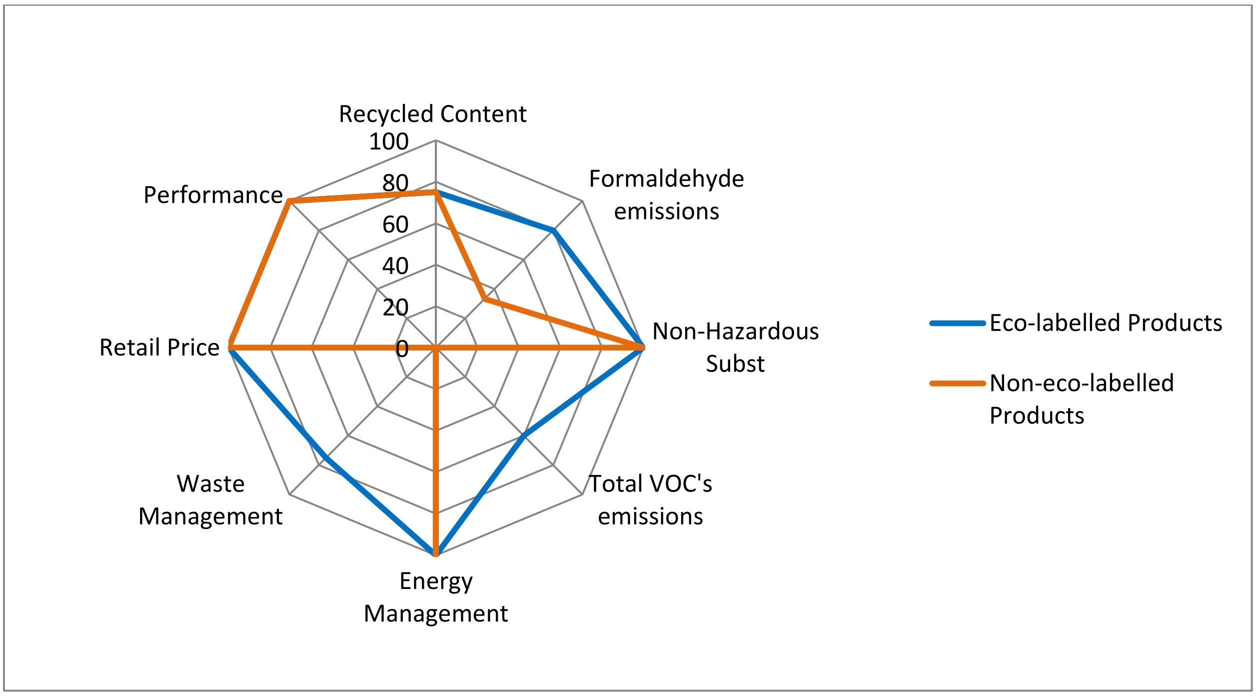

Figure 9 – Comparative analysis of thermal building insulations' attributes - Percentage of selected products appearing above given criteria set.

Figure 9 provides overall analysis of all products attributes for thermal building insulations. The units of comparison are in percentage. Thus Figure 9 outlines a comparative scenario, between eco-labelled and non-eco-labelled products. Results show that eco-labelled products provide more detailed information, regarding most attributes, compared to non-eco-labelled products. More specifically, the last statement is true for: total VOC's emissions, formaldehyde emissions and waste management. Whereas the other remaining attributes: retail price, performance, energy management and recycled content are inside of the same range for eco- labelled and non-eco-labelled products.

4.3.10 Historical Information

Certified thermal building insulation products from this research are: Tasman Pink batts ceiling - year of certification 2004, CRS Bradford Gold ceiling - year of certification 2008, Autex GreenStuf Ceiling-year of certification 2008, and Insulpro Novatherm Ceiling - year of certification 2010.

Historical products data sheet were obtained from three of these manufacturers: Tasman, Autex and Bradford. Insulpro was the only brand which either manufacturers or websites did not make information available, regarding the period before its product certification. For this reason, the historical comparative analysis for this brand was not possible.

The tables 44, 45 and 46 provide historical information from three different thermal building insulation products.

Table 44 – Historical information from CRS Bradford

Attributes	Before Certification (2008)	Current (2013)
Performance	NOT KNOWN	Lifetime warranty (50
Recycle Content	NOT KNOWN	From up to 80%
Hazardous identification	Not - ASCC/NOHSC	Not - ASCC/NOHSC
Formaldehyde emissions	Yes	Yes
Energy Management	NOT KNOWN	Comply with H1 from NZBC

Table 45 – Historical information from Tasman - Pink batts

Attributes	Before Certification (2004)	Current (2013)
Performance	a serviceable life of at least 50 years	a serviceable life of at least 50 years
Recycle Content	35% from products made in south island and 85% north island	from up to 80% recycled glass
Hazardous identification	non carcinogen by the European union	Not - IARC group 3* / NZBC F2
Formaldehyde emissions	NOT KNOWN	≤ 0.05ppm (greenguard req)
Energy Management	Comply with NZBC' H1 clause: Energy Efficiency	Comply with NZBC' H1 clause: Energy Efficiency / Electric glass melter, cut power usage in 50%

Table 46 – Historical information from Autex GreenStuf

Attributes	Before Certification (2008)	Current (2013)
Performance	Lifetime warranty - Comply with NZBC's B2 clause: Durability - 50 years	Lifetime warranty - Comply with NZBC's B2 clause: Durability - 50 years
Recycle Content	NOT KNOWN	45%
Hazardous identification	meets NZBC's F2 clause Hazardous building materials	meets NZBC's F2 clause Hazardous building materials
Formaldehyde emissions	NOT KNOWN	FREE
Energy Management	Comply with NZBC' H1 clause: Energy Efficiency	Comply with NZBC' H1 clause: Energy Efficiency

Results show that all the products changed very little in its structure and requirements; the key aspect regarding historical data is that all product data sheets were more simplified and with limited focus on environmental credentials. However, the scope and the detail of environmental information available to the consumer increased with the subsequent years.

For example, during the data collection, manufacturers reported that technical attributes from the product did not change due to the certification process; however, other changes occurred because of new requirements from the NZBC and other related legislations. Manufactures argued that the main benefit from the ECNZ scheme is that it helps to keep environmental and product stewardship aspects in its focus along with focus on continuous improvement.

4.4 Answers to Research Questions

1- *How does the product's performance differ between eco-labelled and non-eco-labelled products?*

Paints and thermal building insulation products show no difference in performance from eco-label and non-eco-label products. On the other hand, performance from eco-label carpets is higher than non-eco-labelled carpet products.

2- *How does the product's cost (retail price) differ between eco-labelled and non-eco-labelled products?*

Retail prices from eco-labels paints products are higher (more expensive) than non-eco-labelled paints products. For carpets and thermal building insulation, however, the retail price is in the same range for eco-labelled and non-eco-labelled products.

3- *How do specific environmental credentials differ between eco-labelled and non-eco-labelled products?*

For paints products, the majority of the analysed specific environmental credentials (VOC's emissions, hazardous content, eco-toxicity and waste management) shows that eco-labelled products have more eco-friendly characteristics (or inform better credentials to the consumer) when compared to the non-eco-labelled paints products. On the other hand, a unique attribute –amount of recycled content – demonstrates a better development for non-eco-labelled paints than eco-labelled paints.

Carpet products show that information regarding most specific environmental credentials from eco-labelled products outperforms non-eco-labelled products. Specific environmental credentials that can be highlighted for this last statement are: Face fibres', backing's and overall's recycled content, emissions to the environment and waste management procedures.

Thermal building insulation's results show that eco-labelled and non-eco-labelled products do not differ regarding the following specific environmental credentials: Recycled Content, Hazardous Substances and Energy Management. The remaining analysed specific environmental credentials (emissions to the environment and waste management) demonstrate that eco-labelled products better informs these attributes to the consumer comparing to the non-eco-labelled products.

4 - How do specific attributes (from eco-labelled products) differ from before the certification period to after the certification period?

Most products attributes did change overtime; most of them only a minor change others a considerable change. However pressure from the market and governmental regulations plays a much higher impact for these changes rather than eco-labels pressure, indeed, these factors (market and governmental regulation) also influence manufacturers to have their products accredited as most of them already comply with the certification criteria.

4.5 Overall Comparative Study

A comparison from the attributes (from the three analysed products categories) revealed that eco-labelled products display (inform) better their specific attributes than non-eco-labelled products. Figure 10 shows an average of the percentage of products (eco-labelled and non-eco-labelled) that informs their attributes for the consumer.

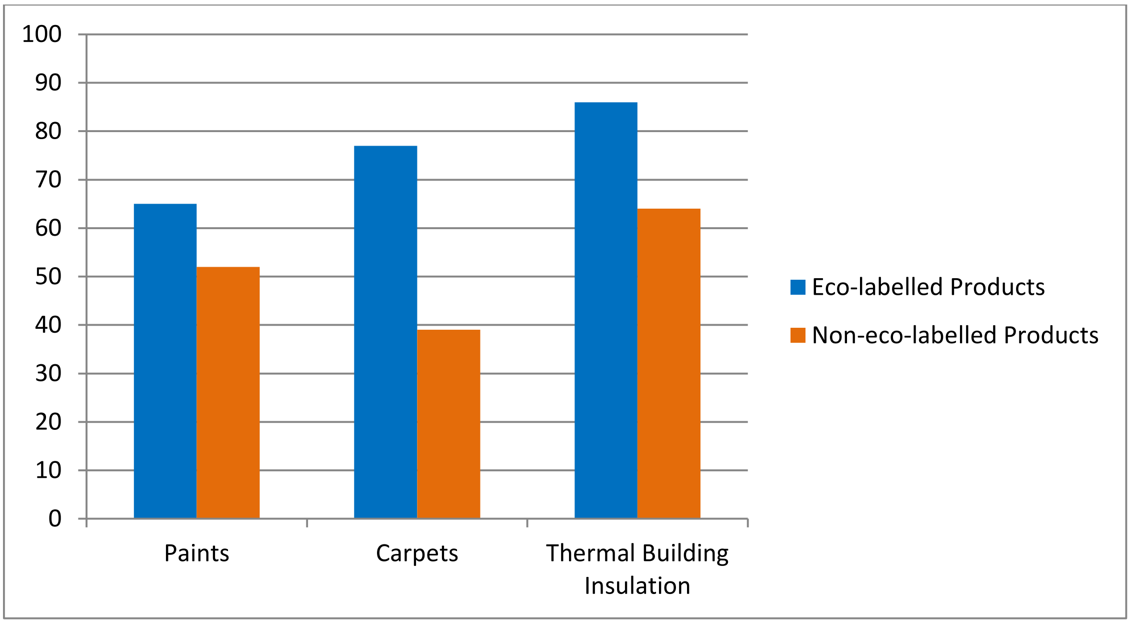

Figure 10 – Percentage of eco-labelled and non-eco-labelled products carrying positive (above criteria) attributes – Average.

In summary, a number of important differences were found between the eco-labelled and non-eco-labelled products. These differences and their implications will be discussed in the following chapter.

Chapter 5– Discussion

This chapter will discuss the outcomes of this research. It is divided in four main sections. First, the general findings, in which main differences between eco-labelled and non-eco-labelled groups' products will be discussed. Subsequently, specific findings from each product group will be discussed; this will be followed by additional findings related to individual product. Finally, the main ideas are displayed in a concise format in the chapter summary.

5.1 General findings

5.1.1 Performance, retail price and environmental credentials

Findings reveal that eco-labelled paints, carpets and thermal building insulations perform as well or better than their non-eco-labelled counterparts. When a value proposition is taken into consideration, however, there are significant differences across the three classes of products. These differences have specific implications for manufacturers wishing to attract consumers who do not incorporate environmental credentials into their purchasing decisions. With respect to the above, this study identified three scenarios present in the New Zealand market.

Firstly, *eco-labelled products show comparable performances but superior environmental credentials*. This group have a premium price and they deliver superior environmental credentials but with similar performance. Paying a premium for eco credentials probably reflects the most common perception associated with environmental products. For example wine producers report the same findings (Delmas & Grant, 2011) timber (Dylan, 2007), automotive industry (Reed, 2007), and fair trade (Loureiro and Lotade, 2005; Loureiro et al., 2002). This situation is reflected in eco-labelled paints appearing in New Zealand market. In such cases, it is likely that manufacturers of paint eco-labelled products will attract environmentally-minded consumers but miss out on many conventionally-focused consumers.

Secondly, *eco-labelled products are superior in environmental credentials but comparable in performance and in retail price*. This situation is reflected in thermal building insulations present in the New Zealand market. In such case, both pro-environmental and conventional consumers receive the same quality of service, which is further enhanced by positive environmental credentials associated with that product. In this study, eco-labelled thermal building insulations inform of significantly lower emissions, presence of waste management practices, and equal performance with no associated price premium. Such situation may assist conditions leading to an increased pool of consumers attracted to eco-labelled products. The environmentally oriented consumers will be drawn to these products because they are looking for the eco credentials. However, the conventional consumers may also include the eco-labelled products in their choice sets because there is no price premium or reduced performance.

Thirdly, *eco-labelled products are comparable in price but inform of superior performance*. Such most remarkable results were identified in the carpet product category, where increased performance and clearly superior environmental credentials were priced the same as the non-eco-labelled alternatives. Consequently, such products open up to the wide spectrum of consumers regardless of the value they place on product's environmental credentials.

Besides the retail price and performance, environmental-related credentials are relevant during the product choice process (Ottman, 1998, 2011; Wang, 2009; Wee, 2007). Results demonstrate that the majority of eco-labelled products (from the three product groups) inform a very low level of VOC emissions, environmentally friendly waste management, and eco-toxicity prevention. When environmental credentials of the non-eco-labelled products are reported, most fall short of the eco-labelling criteria.

Information concerning recycle content and hazardous substances differs between eco-labelled and non-eco-labelled products, depending on the product group. For instance, paint products show higher recycled content materials for non-eco-labelled products, while carpets show a higher recycled content material for eco-labelled products, and thermal building insulation shows an equal recycled material content for both eco-labelled and non-eco-labelled products. In relation to hazardous substances, thermal building insulation products show equal contents for eco-labelled and non-eco-labelled products, whereas paint products show that eco-labelled products are superior to non-eco-labelled products. Energy management was the only environmental attribute that did not show a change from eco-labelled and non-eco-labelled products for all three product groups.

The current research demonstrates that the most of environmental credentials information is superior for eco-labelled products. It may be possible to argue that the non-eco-labelled products manufacturers do not feel that it is important to test pollutant emission levels of their products. They may not be concerned if their products are toxic at their final disposal. Besides that, it is likely that there is not enough encouragement to promote environmentally friendly waste management procedures. However, it appears that the environmental attribute both eco-labelled and non-eco-labelled products' manufactures are aware of is energy management. This could be because it superior performance in this area reduces costs or because energy parameters are "greater attribute" for the media. Concerning the remaining attributes, a general statement cannot be formulated; it is possible, however, to argue that thermal building insulation manufacturers (eco-labelled and non-eco-labelled) do care about the importance of preventing hazardous substances in their products composition.

From all the studied attributes, recycle content is the one that shows the most diverse results among product groups. To generalise from the results, eco-labelled paint manufacturers do not make enough effort to use recycled materials in its products composition. Eco-labelled carpet manufactures demonstrate a greater awareness of the importance of recycled content. Thermal building insulation's manufacturers, again, demonstrate a very stable and environmentally friendly standard for both eco-labelled and non-eco-labelled products; hence, it can be argued that most manufacturers from this group product are more aware of environmentally related issues.

5.1.2 Human and Environmental Health

This section discusses a few environmental attribute findings and how each of the studied products impacts nature and human health. These factors have been widely discussed in the literature (Rajagopalan et al., 2012; Wolkoff, 1997; Blinova et al., 2010).

Although the findings show clear information from eco-labelled and non-eco-labelled products, it also indicates contradictory evidence concerning specifics attributes. More specifically, the findings show inconsistencies between: 1) hazardous substances and emissions to the environment and 2) hazardous substances and eco-toxicity. This statement is valid for both eco-labelled and non- eco-labelled products. From the variety of environmental credentials that are significant to consumer, hazardous propensity can directly influence most of these attributes; for example, emissions to the environment (influences the quality/*hazardous* substances in the air), recycled content (influences *hazardous* waste substances), eco-toxicity (influences the *hazardous* substances to the aquatic environment)(Ottman, 2011; Woodside, 1999; Ryding, 1992). As the environment and human health are also closely connected with the propensity of hazardous substances (that can be found in the analysed products), it is a very pertinent theme to be discussed in this study.

Nevertheless, a lack of transparency regarding the classification from hazardous and non-hazardous products was found during the data analysis. This matter focuses primary on thermal building insulations and paints product groups. For instance, the findings showed that some thermal building insulation emit formaldehyde; even though the full sample (eco-labelled and non-eco-labelled) of thermal building insulation products are classified as non-hazardous and formaldehyde is classified as a known human carcinogen (cancer-causing substance) (EPA- United States Environmental Protection Agency, 2013; Global Health & Safety Initiative, 2008). Perhaps the hazardous substances tests may not be strict enough when it comes to carcinogens such as formaldehyde. All of the analysed products comply with the F2 clause from the NZBC – Hazardous Building Materials. It is not clear, however, if formaldehyde presence makes a difference when the product is considered as being a hazardous or not for the NZBC's clause F2. From the nine thermal building insulations analysed, only two (Kanauf – Earthwoll and Autex – GreenStuf) inform consumers that their products are free from formaldehyde. Today, certain new-generation thermal building insulations are being manufactured using a bio-based technology for the binder process whereas it does not need to use formaldehyde, phenol acrylics, bleaches and others. Also, other brands possess technologies that can trap the formaldehyde avoiding its emission. Examples of these brands are: Terra Lana (non-eco-labelled), Autex (eco-labelled) and Kanauf – Earthwoll (eco-labelled).

A similar lack of clarity about hazardous substances can be found in paints. Findings indicate that five products were considered hazardous, seven non-hazardous, and three not known. Paints products in New Zealand are classified under the Hazardous Substances and New Organisms HSNO (Act 1996). Products are classified as: *9.1C* hazardous for the aquatic environment, *6.3A* hazardous for the skin and *6.4A* hazardous for the eyes. As the majority of the analysed products are classified as *non-hazardous*, none of these products possess any of the above classifications; consequently, none of them would be hazardous for the aquatic environment (9.1C). However, eleven products (including all the non-hazardous ones) inform the consumer to "Avoid" or "Do not allow" to dispose the rest of paints in waterways due to the risk to cause eco-toxicity. Hence, it would be possible to claim that all the fourteen analysed products (including three non-reporting products) should have the classification 9.1C-hazardous for the aquatic environment.

5.1.3 Information availability / Barriers

Standards' criteria

Diverse environmental certifications are in the market today. These certifications, as mentioned in the second chapter of this work, can be related to only one field (such as building materials/products) or to numerous fields. In addition, some certifications are single-attribute related, others multiple-attribute related (Peri & Rizzo, 2012; Rajagopalan et al., 2012). Their criteria also change: levels, units, principles, and others (CRI - Green Label, 2012; ECNZ, 2008; ECNZ, 2009; ECNZ, 2010; Greenguard, 2010). Lack of transparency and confusion on the subject of certifications criteria was found during the data collection/analysis. The next paragraphs will present some examples of these inconsistencies.

The level of VOC emissions (concentration in the air) can be displayed in diverse units, including g/l, mg/m^3, ppm, among others. The type of unit depends mostly on the type of material (for instance, the emission concentration changes significantly from paints to carpet), certification/testing body criteria, and testing methods. Besides different units, there are also different requirements regarding the amount/concentration of the emissions. These will depend also on the product type and specific characteristics. For instance, paints present different level of gloss (e.g., flat/matt, glossy, semi-glossy and others), and the more glossy the paints are, the higher the level of VOC emissions is (Rider et al., 2011; ECNZ, 2009). Hence, when a consumer wants to compare products based on their level of VOC's emission, they will probably face different units and levels of measurements. It appears that there is no transparent and easy-to-access information regarding this issue for consumers in the New Zealand market. It is likely that this adds to consumer confusion when looking for a low VOC emission product.

Contradictions found

By the middle/final stage of the data collection, a number of contradictions were found in the ECNZ website. These inconsistencies include:

- ECNZ website displayed that no product was certified under the wool carpets category. For this reason, only synthetic carpets were selected to be analysed. In the final phase of the research, however, Cavalier Bremworth (tile carpet 90% wool and 10% synthetic) was found (in the company website) to be certified by ECNZ, which was not displayed in the certification website.

- The synthetic carpets section in the ECNZ website, in displays diverse brands and products. These types of carpets were selected because of the amount/quality of environmental information that they would provide to the study dataset (convenience sampling). Products were chosen to be analysed, but, by the middle/final stage of the data analysis *Jacobsen's* carpets were discovered (in the brand website) to have detailed environmental information. They were actually certified by ECNZ, but they were not displayed as a certified product in the certification website.

- Irvine International is one of the brands that have some of their products certified by ECNZ. A few products that are displayed in ECNZ website were discovered to no longer be available in the New Zealand market. In addition, others products that are available in the market and is certified by ECNZ such as the carpet tile "point of view" is not displayed in the ECNZ's website under Irvine International brand.

Besides causing a delay in the data analysis process, these inconsistencies also could cause confusion for green consumers who want to purchase ECNZ accredited products. The ECNZ website should be a reliable source of certified products, and should represent the current range of certified products that are available in the New Zealand market.

The discussion above covers the general findings, where conclusions can be drawn for all studied products. The next section discusses specific characteristics related to each product group.

5.2 Product group specific findings

This section is related to specific findings from each product group: paints, carpets, and thermal building insulation. Barriers and facilities were disclosed during the data collection and analysis.

5.2.1 Paints

Paint products were the easiest and fastest data to collect and analyse compared to the other products. The main reasons are most likely to be:

- Good quality and comprehensive information that manufacturers provided in their websites;
- Informed specific and detailed characteristics of certain attributes (such as hazardous content classification numbers and specific VOC emissions concentration);
- Several products from different set categories were available in the New Zealand market. For instance, numerous products of the same range (i.e., same area of application, same level of gloss, etc.) were available. Further, all of the manufacturers used roughly the same nomenclature across products and brands.

Hence, it is possible to say that these scenarios would facilitate the consumer when choosing within a similar range of green products. In general, it would be easier for the consumer to be aware if paint products are more environmentally friendly or not in comparison to carpets and thermal building insulation products. It also leads to the assumption that paints manufacturers are more aware of its products' environmental credentials than the other studied products.

5.2.2 Carpets

New Zealand's market has several carpets manufacturers and diverse products. However, finding specific products that informed the consumer across most of the environmental credentials was a challenge.

Information on carpets' environmental credentials is limited. Also, products' data sheets often show only technical specifications such as pile weight, machine gauge, tile thickness and design direction. Moreover, carpets products do not provide MSDS or any other safety related document (where information regarding hazardous propensity and detailed raw materials are normally displayed).

Most of the products have specific data sheets that would display little information, whereas the remaining information was provided as a general statement and it is applied to all products from the same manufacturer. This information could be found in separate documents such as general “sustainable brochures”, manufacturers’ websites, or by asking the specific question to the manufacturer/supplier by phone or in person. From all the researched brands, Modulyss-Heritage was the only one that demonstrated enough information in a unique document for each product, and it included several crucial environmental credentials. This situation may be due to the fact that not enough tests (related to the analysed environmental credentials) are done on most carpet products.

Another interesting point was disclosed concerning carpets products: specific carpets products are sold by numerous specialized carpets stores with different brands, names, and styles. It could be argued that these types of “specialized stores” would have more prepared and trained retailers to answer specific questions to consumers, as there is only one type of product to sell. However, the norm was a lack of knowledge and awareness of environmental certification from retailers. Some of them were not aware of eco-labels. Others did know, but thought that it would not apply for carpets, while others said that they did not have any eco-labelled carpets in that store (yet they were selling them). Some information regarding eco-labels can be found in the products’ brochure or attached to the product (as a sticker). Consequently, it can be argued that retailers do not receive enough training concerning eco-labels and/or that environmental related information is not considered important for the selling process.

5.2.3 Thermal Building Insulation

The characteristics across every thermal building insulation product were very different. Manufacturers in New Zealand even have different names and descriptions for essentially the same product. For example, the following brands products describe similar products:

Tasman Pink Batts – “Flexible glasswool insulation”

CSR Bradford Gold – “Compressible glasswool insulation”

Kanauf Earthwoll – “Inorganic glass fibres”

Polygold premium – “Glasswool and Phenol”

Premier A Grade Insulation – “Glasswool insulation”

All of the above products have the same characteristics, but it is not clear enough for the consumer when different terminologies are used for the same product type. Hence, it is likely to become more difficult for the consumer to recognize product’s similarity (from brand to brand).

Contrary to using different terminologies, all of the most of these products' data sheets showed information about compliance with the NZBC clauses (H1-Energy Efficiency Provisions, F2- Hazardous Building Materials, B2 – Durability and others). As the ECNZ criteria set for this research is mainly based on the NZBC requirements, most of the thermal building insulation products actually passed the criteria. However, it might be possible to argue that NZBC criteria is not clear enough; nor are their testing procedures described in enough detail. During the data collection process, a supplier argued that they do not know detailed information about the testing procedures (in the laboratory). This particular supplier pointed that the lack of accurate/detailed information regarding specific environmental credentials would influence the selling process in a negative way. Retailer, on the other hand, argued that it is "hard" to sell a product without knowing further detailed information. It appears that the availability of more detailed testing procedures regarding products' environmental credentials would be valuable for retailers and consumers.

Another point that is shared with carpets is the lack of information concerning emissions of total VOCs (TVOCs). Findings revealed that only a very small sample of products informs this kind of emissions. Therefore, it appears that either the products do not emit a low level of TVOC (hence, there is not much interest from manufacturers to inform these values) or that manufacturers do not measure its level of emission, and for this reason is unable to provide information.

Most likely, the second scenario is the one that represents this analysis. One of the reasons for this assumption might be for the fact that manufacturers only test formaldehyde emissions and not TVOC. The exceptional characteristic that thermal building insulations have regarding its emissions of formaldehyde (it is crucial element normally found in these products). The second chapter of this study, section – "Emissions to the environment", explains that formaldehyde is one of the compounds from the TVOC's emissions; hence, it is possible to argue that manufactures would prefer to focus only in formaldehyde emissions when testing their product, rather than TVOC's emissions.

This discussion was related to issues related to specific group; the next section is based on more specific characteristics or issues related to an individual product.

5.3 Idiosyncratic findings – individual products

Unique characteristics were perceived during the data collection and analysis concerning individual products or brands; this section will detail some of these findings.

5.3.1 Enviropaints

Findings revealed that across all the paints brands, “Enviropaints” was the one that provided the most curious information. Seven different attributes of paints were analysed: performance, retail price, emissions to the environment, recycled content, hazardous substances, waste management, and eco-toxicity. Only one of them (recycled content) showed a great disparity; from the 14 paints products, only one -“Enviropaints Recreated Water Based Low Sheen”- has recycled contents (up to 80% of recycled material) in its product formulation. None of the products from other manufacturers provided any recycled material as paints is not a type of product that normally uses recovered materials in its composition. It appears that this would induce the consumer to think that the recovered paint is an environmental friendly product. However, this product does not inform the consumer about any of the other important environmental credentials, such as VOC emissions, propensity to eco-toxicity, or hazardous substances. Further, most of the Enviropaints products did not include product’s data sheets and/or MSDS. These documents would certainly help consumers to analyse the main characteristic from a certain products and also evaluate the procedures (especially during the application phase or final disposal) that must be followed to keep a healthy and safe environment.

Also, Eviropaints is unique in that consumers can only buy their products online or at the factory in Otaki, Kapiti Coast. As the majority of the products are sold online, it is very important for consumers to have products’ information available digitally in order to facilitate the purchase. Product data sheets and MSDS help consumer to analyse and compare the main characteristics from each product, especially when consumers do not have the option to go to a regular store and choose the products, as it is the case of Enviropaints products.

Moreover, it is also important to argue that a brand that is named as “Enviro” should have more environmental friendly characteristics than recycled content materials and a zero waste programme. This is also the case for a number of other non-eco-labelled manufacturers that want to promote themselves as environmentally-friendly. In addition to Enviropaints, Biopaints, Eco-insulation and Ecofloor (limited certification) have *nature-friendly* names. Even though each of them has at least a single characteristic that would considered environmentally friendly, they are smaller enterprises (when comparing to the eco-labelled paints manufactures) and none of them have been in the market long. These might be the reasons for the lack of certification. It is hoped that these brands will improve their products, broaden their reporting and find accreditation with an environmental certification.

5.3.2 Paint Tech Living Shield

It may be argued that Paint Tech employees do not know enough key characteristics from their products and that is why they do not provide complete information in terms of MSDS and product data sheet. Results showed that Paint Tech products are tested (VOC's emissions) by a group called "Eurofins product testing", their criteria for VOC's emissions depends on the product subcategory, such as: "Interior matt walls and ceilings (gloss <25@60^{o})" requires a maximum VOC's emissions of 30g/L and "Interior glossy walls and ceilings (gloss>25@60^{o})"requires a maximum VOC's emissions of 100g/L. However, paint tech does not provide information regarding its level of VOC's emissions neither of gloss level, it only informs that its products pass Eurofins criteria. Thus, consumers cannot realistically know paint tech products' level of VOC's emission.

The main characteristic of flat paints is normally known as either gloss free or very low gloss level. Therefore, for this research analysis; "Paint Tech Ceiling Flat Premium" is assumed to have a gloss level lower than 25 at 60^{o}; which would be considered a low VOC's emission paint. On the other hand, "Low Sheen" paints category possesses gloss in its composition, bit the amount is unknown. Paint Tech suppliers/manufacturers could not inform the level of gloss that the product "Paint Tech Living Shield Low Sheen" (from product data sheet, MSDS, website or phone calls). Hence, it was assumed that the level of gloss from "Paint Tech Living Shield Low Sheen" is higher than 25 at 60^{o}. As the average gloss level for regular low sheen paint is around 25 at 60^{o}. This would be the maximum allowable for the eurofins criteria that permits a VOC's emissions up to 100g/L.

5.3.3 Belgotex Baltimore

The carpet Belgotex – Baltimore is an eco-labelled product, certified by ECNZ. Yet, only limited information regarding this product's environmental credentials could be accessed. It is likely that their "production specification fact sheet" and website do not provide the necessary information that a green consumer would require to make an informed purchase. This product is accredited according to the ECNZ – EC-33-12 criteria which include a diverse and complicated set of attributes such as amount of recycled content for the face fibre and backing, "Take Back" programmes, waste minimization and VOC's emission. From all of these attributes, the compilation of VOC's emissions is the only one that is mentioned in their product data sheet and website. Even though ECNZ regulation requires these attributes compliance, consumer cannot confirm them in any of the product's published characteristics.

Apart from the reporting issue above, there is also another problem concerning the availability of Belgotex – Baltimore in the New Zealand market. Belgotex is an international carpet brand and its products are distributed in the national market by the supplier Irvine. However, retailers seem to be confused by this and some do not even know about the existence of “Belgotex-Baltimore” carpets in the national market. After a long period of data collection it was found that Belgotex Carpets displayed in the ECNZ’s website appear in the national market using a different name, which was given by the supplier, Irvine. Thus, it is likely that New Zealand’s consumers will find diverse barriers to purchase (and find) Belgotex products.

5.4 Chapter summary

This study demonstrated that signalling environmental credentials through eco-labelling schemes does not represent a purely binary situation – products either show superior environmental credentials to its non-eco-labelled counterparts or not. It is identified that value propositions associated with eco-labelled products are complex and that differences exist across product groups.

In addition, a lack of information and awareness related to green building products credentials and retailers, suppliers and producer was found. Misinformation and contradictions were discussed in this chapter as well as specific products idiosyncratic findings.

Chapter 6– Conclusions, Contributions, Limitations and Further Research

6.1 Conclusions and Contributions

The overall objective of this study was to assess performance, price and environmental credentials on a range of building products. Building products reviewed by this study included paints, carpets and thermal building insulations available in New Zealand market. This work explored how eco-labelled products differ from non-eco-labelled products on a sample of 38 building products. It adopted a descriptive-exploratory approach where diverse environmental credentials such as recycled content, emissions to the environment, energy management, waste management, eco-toxicity and hazardous substances were analysed. Moreover, this study evaluated the anticipated expected trade-offs between price and product's performance and environmental credentials. In addressing the research questions, this study delivers detailed product specifications related to the key identified environmental credentials consumer may consider before making the purchase. There was found no evidence to suggest that the producers are using eco-labels to hide poorly performing products or as green-washing. This research reveals that eco-labelled paints, carpets and thermal insulations perform as well or better than their non-eco-labelled counterparts, however, with different flavours of value proposition across the three classes of products.

This work is intended to benefit customers and the building industry. The outcome will assist interested parties to understand building products' main environmental credentials; it also promotes strategic decisions toward implementation of environmentally-focused product designs and manufacturing practices. Moreover, this study provides a current understanding of the best available options for selected building products available in New Zealand market. Eco-labelling, thus, can be viewed as a catalyst of positive environmental awareness and changes in the building industry.

This research also traced the development of eco-labelling standards mostly those developed by ECNZ in the building products sector. There are several organizations in the world support sustainable building practices. In New Zealand, New Zealand Building Council (NZGBC) and the Building Research Association of New Zealand (BRANZ) encourage sustainable construction practices in the country. It is fundamental that not only the building industry but also related companies (including products' manufacturers) have a common understanding of what constitutes a sustainable building process in order to engage in a network that can offer such a service.

Besides these industry-wide benefits, it is important to highlight some individual benefits for each affected stakeholder. Thus the outcomes of this study inform:

Product manufacturers: Manufacturers of selected products will be able to assess their product performances relative to the eco-label criteria. This information is actually useful for both eco-labelled and non-eco-labelled products of selected product groups. This study, thus, increases awareness of product's associated impact on the environment. Analysis of historical data related to eco-labelling certifications, demonstrate market trends to emphasise the mitigation of products' environmental impacts without jeopardising product's cost or its performance. Building Industry: The usage of the appropriate sustainable products can reduce the amount of waste generation, the consumption of natural resources, the repairing costs and change the processes into a more efficient approach. These measures will enhance the green market and promote the optimization of this sector.

Consumers: This work will help customers to understand the differences between eco-labelled and non-eco-labelled product and thus minimise the reported confusion. This study also informs the consumers about the importance of environmental credentials related to the selected building products. Consequently, consumers will be able to choose the right product for their specific need. The use of an eco-labelled product will provide a more efficient building with reduced energy costs, waste and a healthier living environment.

6.2 Research Limitations

Despite the contributions, this study recognises its limitations. This work is relied on secondary data, and this was based on information provided by manufacturers and publically available during the period of data collection. Also, any claims about a particular environmental credential were taken at face value and not tested or confirmed.

In addition, important information related to the environmental credentials may not be absolutely traceable within the typical supply chain of manufacturer – supplier – retailer. There may be inaccessible information related to the retailer sector that this study may have not identified. It is important to note that analysed environmental credentials are more related to the manufacturing procedures than to the retail sector. Besides that, this study somewhat revealed that retailers are not necessary aware environmental credentials related to the building products.

Another obstacle this study faced was contradictions between certifications websites (such as ECNZ) and manufacturers/suppliers websites. These inconsistencies may also have limited on the outcomes of this research. This point was thoroughly discussed at the Discussion chapter and a wide range steps to minimise the risks of working with misleading information were employed.

Furthermore, this study focused on consumer willingness to purchase a product based on retail price, performance and selected environmental credentials. What this study, however, did not do, was taking into consideration consumer's loyalty, and the product's brand stability on the market. If these parameters would be also be taken into account, the outcome would address a more detailed and precise view from consumer's wiliness to choose a product. The eco-labelled paints sample were represented by multi-national and known stabilised brands, whereas their non-eco-labelled counterparts were all national and recently created brands in the New Zealand market.

6.3 Further Research

Results of this study offer a range of research opportunities. A possible future research avenue could apply adopted research design of this study to additional products and markets. Furthermore, results related to the three product groups yielded variations that could be further explored on a wider range of products. Other future studies could also explore not only the extent eco-labels on building products signal environmental credentials but also what possible opportunity losses occur when eco-label does not fully inform consumers. Clearly, if green products aim to become mainstream products, creating a new purchasing norm, other issues than environmental credentials will need to be addressed in order to attract the wider community of consumers. Furthermore, given the notion of impure public goods associated with green products, future research might also focus on whether eco-labels should signal information on performance and product quality as well as environmental credentials?

Besides that, a more embracing study related to a social approach could be taken into account. The main focus could be concerning the consumers' perception on key environmental credentials from the building industry, and whether these environmental credentials set in the eco-labels criteria are crucial or not for consumers' perception. Another similar topic could be related to the main barriers that manufacturers face with respect to key environmental credentials of building products.

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