Planning for the Effective Reuse of Products in the New Zealand Building Industry

A Dunedin Case Study

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Abstract

Modern society generates a growing waste production, associated with natural non-renewable resources depletion. Notably, the building and construction sectors are believed to consume approximately half of the planet’s resources and to be responsible for around 30 to 50% of waste production. Awareness has grown worldwide, particularly within the themes of sustainable building and resource consumption. The aim of this thesis is to evaluate the feasibility of the reuse of products in the building industry and to present recommendations to promote this activity. This research is focusing on the Dunedin context and recommendations are made at the local and national levels.

A literature review has been undertaken where eight factors influencing the reuse of building products have been identified: solid waste management, deconstruction, design for reuse and other similar design, designing with salvaged products, stakeholders, economic influence, statutory framework, and sustainable building. In addition, interviews with key informants on the building and waste industries have been conducted in Dunedin and Wellington to identify the local barriers and opportunities for this activity.

Results have demonstrated that the reuse of building products is embedded within broader notions such as building with sustainable building and heritage buildings, demolition, and construction and demolition waste. There is currently a lack of research on topics relative to the reuse of building products and a lack of leadership to encourage this activity and educate the New Zealand population accordingly. Although some New Zealand legislation is in theory favourable to this activity, the building legislation hinders the reuse of products in the structure of buildings. Economic factors are also identified as a critical aspect of this activity as it can be commercial. A set of recommendations in these five areas has been designed to provide a better framework for and to encourage this activity.
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<th>Full Form</th>
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<tr>
<td>BRANZ</td>
<td>Building Research Association of New Zealand</td>
</tr>
<tr>
<td>BREEAM</td>
<td>Building Research Establishment Environmental Assessment Method</td>
</tr>
<tr>
<td>CIB</td>
<td>Conseil International du Bâtiment, or in English, the International Council for Building</td>
</tr>
<tr>
<td>C&amp;D</td>
<td>Construction and Demolition</td>
</tr>
<tr>
<td>DCC</td>
<td>Dunedin City Council</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>NZGBC</td>
<td>New Zealand Green Building Council</td>
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<tr>
<td>NZHPT</td>
<td>New Zealand Historic Places Trust</td>
</tr>
<tr>
<td>ORC</td>
<td>Otago Regional Council</td>
</tr>
<tr>
<td>W115</td>
<td>Working Commission 115 from the CIB</td>
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</table>
1. Introduction

The Brundtland report *Our Common Future* introduced worldwide the paradigm of sustainable development (Brundtland and World Commission on Environment Development, 1987). One of the aims of this ideology is to slow down the adverse environmental effects due to human activity including those relating to agriculture, industry, energy use and industrial waste production on the planet.

Within the last twenty years, an area of increasing concern in sustainable development has been the environmental effects of building. This area of research has given birth to the concept of sustainable building as the effects of building are significant. According to Berge and Henley, “the building industry is the largest consumer of raw materials in the world today after food production” (2000, p. 5). Moreover, according to Storey (2008), approximately half of material resources taken from earth are building-related. Even more alarming is the observation made by Berge and Henley that the “building industry has not only become a major consumer of materials and energy; it has also become a source of pollution, through the production of building materials and the use of pollutant substances” (2000, p. xi). Storey also estimates that the building industry releases approximately half of the total amount of waste produced worldwide (2008).

Storey considers that ‘material resource depletion’ or the depletion of non-renewable resources is a ‘tertiary priority’ in sustainable building, behind energy consumption and water deficiencies (2008, p. 8). This issue is generally linked to an efficient construction and demolition (C&D) waste management. As a result of consumerism, waste has systematically been buried and has not been understood as a resource. Alternatives to landfills have later been developed for C&D waste, including reuse and recycling. However, these waste management options are often confused by society and even by researchers specialising in construction material stewardship.

Overall, reusing building products offers the possibility to value salvaged products from end of life buildings. According to Lazarus, there are huge opportunities in the recovery and the reuse of building products (2005). There is a consensus in the literature that reusing building products is both a traditional activity and a substitution to the use of new products.
Gorgolewski considers that prosperity, progress, fashion, and the disposability of products have negatively influenced their recuperation (2008), explaining the current wide use of new building products. As a result, the reuse of building products, similar to what happened in the past, appears to be a solution worth examining (Gorgolewski, 2008).

### 1.1. A Gap in the Literature on the Reuse of Building Products

On an international scale, one of the goals of research on sustainable building is to provide opportunities to better use building products. Several international construction and building research organisations identified in *Agenda 21 on Sustainable Construction* the need to provide an international framework for sustainable building (International Council for Research and Innovation in Building and Construction, 1999). This report seeks, among other aims, to address the issues of building’s resource consumption and of its waste production. It lists a series of research needs; among which some of them seek to provide an efficient use of building products and a better C&D waste diversion from landfills (International Council for Research and Innovation in Building and Construction, 1999).

Most of the information on a sustainable use of building products is issued by the Working Commission 115 (W115). This group, gathering academics from various countries, belongs to the International Council for Research and Innovation in Building and Construction, known as CIB. It complements the research carried out by Task Group 39 from CIB, who focused on deconstruction (Storey, Chini, and Schultmann, 2008). The W115 carries out research on construction materials stewardship. It has particularly identified a series of factors influencing the use of building products: building legislation, the understanding of sustainable building, demolition/deconstruction practices, waste legislation and waste hierarchy, and C&D waste management.

Research focusing only on reusing building products has occurred in Canada and in the United States (Kernan, 2002; Public Architecture, 2010). Results of case studies involving this activity have allowed many lessons to be learnt for the building community. The role of building professionals in commissioning and selecting products has been highlighted, as their engagement is imperative to allow for a maximum reuse of building products. Professionals must be flexible in their design and in their choice of products. Anticipation is required to obtain products as they are available in limited quantities.
In New Zealand, the issue of C&D waste has been handled as a single issue since 1995 through the Project Construction + Demolition, which aimed to decrease the amount of C&D waste landfilled (North Shore City Council, 2010). This scheme has later been included in a wider project supported by the building and recycling industries and the government: the Resource Efficiency in the Building and Related Industries (REBRI) programme. This programme now aims to provide resources to the building industry to:

- reduce waste disposal costs
- save money on raw materials
- use materials more effectively
- reduce the environmental impact from landfill disposal
- maximise the amount of waste diverted from landfills and cleanfills
- minimise contamination and damage
- meet the requirements of the construction or demolition client and the recycling operator (Building Research Association of New Zealand, n.d.-i).

Supporters of the REBRI programme are engaged in reducing the amount of C&D waste and in using building products more efficiently. However, their involvement in the reuse of products is limited as it is not their primary concern. This activity is acknowledged and presented as good practice within the 2005 REBRI programme ‘DESIGN AND PLANNING – waste reduction’ guide. The researcher has found that this document provides a few examples of reusable products and some general advice on the choice of products to be used. However, this guide is incomplete as it misses specific relevant information, such as the legislation requirements associated with this activity, to fully support the building industry in employing this type of product.

Significant research has also been carried out by staff from Victoria University, Wellington. Some of these researchers report to the W115, particularly Storey. Research has focused mainly on the North Island, in Auckland and Wellington, high-growth locations with a significant population. Their findings are that lots of efforts have been made in New Zealand to research on ways to divert C&D waste from landfills. Central government, local authorities, and non-for-profit building and waste associations have identified policies and processes to reduce the amount of C&D waste landfilled. These researchers have also found that the demolition and building industries are increasingly diverting C&D waste from landfills. However, research is missing on what the New Zealand legislation allows in terms of reuse of building products.
1.2. Scope of the Research

In literature, researchers on the efficient use of building products usually adopt a definition of reuse fitting their study, optionally including recycling. Consequently, the definition of the reuse of building products adopted in this research is a combination of three definitions. The definitions for the Building Research Establishment Environmental Assessment Method (BREEAM) help refine the extent of this study by precluding the recycling of building products from their reuse (BRE Global Ltd, 2011). The definition of Paduart, *et al.* containing the wording in “a new building or elsewhere in the same building” helps provide a scope for this study, as well as the definition of Saleh and Chini specifying that building products are “to be used in a similar or different application” (Paduart, *et al.*, 2009, p.19; Saleh and Chini, 2009, p.30).

Therefore, the definition adopted for the term ‘reuse’ in this research is the following one: activity of using a building product which has had a previous use, without a prior treatment or after minor reparation, cleaning, or alteration. For example, the reuse activity can involve the cleaning and shortening of a salvaged beam to fit into a smaller space. The salvaged products can be employed for a similar or different application than their original use, seen or hidden, either in the same building or in another building, either when constructing a new building or altering an existing building.

This study is also narrowed to the use of products from buildings, excluding the use of products from construction, e.g. products from civil engineering projects, mining, or quarrying.

Dunedin presents a distinctive configuration to be chosen as a case study. It has some education departments which are active in sustainable building. The Dunedin City Council (DCC) values heritage buildings in its territory by promoting their adaptive reuse. The heritage department is also giving more value to heritage building products and is currently considering salvaging and reusing these products as an option to maintain these buildings. In addition, previous research in New Zealand has focussed on densely populated areas with significant growth. The case study of Dunedin presents an alternative view to research from Victoria University by analysing the situation in an area with a limited growth. The reuse of building products is studied in Dunedin and more generally in New Zealand, although overseas settings are analysed in Chapter Two to provide an international context.
to this topic. The case of Christchurch is also excluded from the research scope as data is not readily available due to the 2010 and 2011 earthquakes.

1.3. Context of the Research
Little reference in the New Zealand legislation is made to the sustainable use of building products. Currently no specific legislation or regulation defines either the reuse of products in the building industry or the notion of deconstruction. The only section which can be related to the reuse of building products is Section 4 Principles to be applied in performing functions or duties, or exercising powers, under this Act, subsection (2) from the New Zealand Building Act 2004:

(2) In achieving the purpose of this Act, a person to whom this section applies must take into account the following principles that are relevant to the performance of functions or duties imposed, or the exercise of powers conferred, on that person by this Act:

(n) the need to facilitate the efficient and sustainable use in buildings of—
   (i) materials (including materials that promote or support human health); and
   (ii) material conservation.

Section 4 of the Building Act 2004 details the principles guiding the decision-makers to achieve good practice. They are established for the Minister for Building and Construction, the Chief Executive of the Department of Building and Housing, and the building consent authorities (section 4(1) of the Building Act 2004). These principles are not mandatory; they are listed in the Building Act to guide these stakeholders to adopt good practice. Therefore, subsections 4(2)(n)(i) and (ii) of the Building Act do not require the building industry to conserve products, and consequently do not explicitly encourage them to reuse products. Consequently, the New Zealand building legislation does not offer any framework for this activity.

1.4. The Research Problem, Aim and Objectives
The inefficient use of building products has been acknowledged in New Zealand and there is, in particular, a lack of information available for building professionals to know whether it is possible to reuse building products. Therefore, this thesis aims to evaluate the feasibility of product reuse in the building industry and to present recommendations to extend this practice. To achieve this aim, this research employs a case study approach based on Dunedin City and the following objectives guide the research:
1. To investigate to what extent the building industry in New Zealand currently reuses products.

Objective One seeks to understand how common this practice is. It also aims to provide a snapshot of this activity, by defining how this activity occurs, by presenting the building products which are worth reusing, and by examining the sectors relevant to it.

2. To identify the barriers against and the opportunities for the effective reuse of products in the Dunedin building industry.

A study of the current trends in Dunedin regarding waste management procedures, the practice of reusing products when building and renovating, and the role of governmental agencies, local authorities and any other stakeholder likely to be involved in this initiative is undertaken under this research objective. Generally, Objective Two seeks weighing positive and negative factors influencing the reuse of products locally.

3. To develop recommendations for the building industry to encourage the reuse of products in Dunedin and more generally in New Zealand.

Objective Three suggests opportunities to expand the reuse of building products. The recommendations are two-fold: some apply specifically to Dunedin and the other ones are designed to be adopted at a national level.

These research objectives combined together guide the methodological approach adopted in this research.

1.5. Value of the Research

This research fills a gap in the literature by investigating on an inter-disciplinary topic. Indeed, the reuse of building products is the cornerstone of the building, demolition, and waste industries. Although Storey and other staff members from Victoria University have studied this activity within the theme of deconstruction in New Zealand, it has not been specifically researched as such in the Dunedin context. In addition, the link between reuse of building products and heritage preservation has been made explicit for New Zealand in this research.
This thesis also contributes to the research already carried-out within the REBRI programme by analysing the opportunities for this activity. It contributes to the work done by Storey and his co-authors on construction materials stewardship, recovery and diversion from landfills, by studying the situation in an area with limited growth.

Target audiences are all the stakeholders involved and likely to be involved in the reuse of building products. These include government agencies, local authorities, legislators, researchers, planners, education agencies, building professionals, and solid waste managers.

1.6. Methodological Approach
A review of the relevant literature has provided a theoretical base for the research. The literature review has focused on a snapshot of the construction sector, waste management and demolition. Academic documents, including peer-reviewed journal articles, conference papers, and governmental documents have been consulted on waste and especially C&D waste management, building products recovery, reuse of products, and relevant legislation. For this purpose, national and international sources have been sought. In addition, some international, national and local legislations and policies have been analysed in relation to building, heritage buildings and to solid waste management.

The research has been undertaken in Dunedin. The key informant interviews have been conducted with solid waste managers and the building industry to get an accurate representation of the situation in Dunedin and of rest of the country. Other key informants have been interviewed because of their knowledge of the Dunedin context. The interviews have allowed for in-depth information to be gathered in an open and flexible manner.

1.7. Thesis Structure
Following this chapter, Chapter Two sets out the theoretical basis for this thesis. It reviews the academic literature on the building sector and its key areas of debate. Waste management practices are also analysed and key agencies related to the topic in both sectors are presented. This study is therefore located within the existing body of literature.
Chapter One

Chapter Three details the methodological approach undertaken in this research. It justifies the adoption of a qualitative method to collect data and argues the choice of Dunedin as a case study for this research.

Chapter Four focuses on the New Zealand and Dunedin context. It presents and analyses the national and local legislation related to the reuse of building products, as well as the stakeholders which could promote this activity.

Chapter Five gives effect to Objective One. It presents the findings of the research, particularly by focusing on the explanatory side of this research. It examines how reusing building products is common in New Zealand. Then, it identifies the building products that are reused locally, and the complexity of this activity, requiring preparation and anticipation. It sets the basis for the rest of the thesis, providing a better understanding of the local context and of the factors impacting, positively or negatively, on this activity.

Chapter Six gives effect to Objective Two. It analyses the factors influencing the reuse of products, and the opportunities highlighted in the literature and by the key informants to better promote this activity. These factors are listed within five main themes, which are: research, education, leadership, economy, and legislation.

Chapter Seven draws together the findings of this research and provides some recommendations to encourage the reuse of products in Dunedin and more generally in the New Zealand building industry and emphasises areas which need more focus.

The next chapter introduces the contents of the academic literature and government documents related to buildings, waste, and the reuse of products.
2. Literature Review

Chapter Two provides the theoretical framework for this study. It aims to review, analyse, summarise, and reflect on the relevant literature relating to this research topic. Appropriate sources within international and national academic papers, governmental legislation and reports are quoted in this chapter. The research is all the more valuable since a limited amount of information is available on the sole topic of reuse of building products.

Most of the information on a sustainable use of building products is issued by W115, researching on construction materials stewardship. It complements the research carried out by Task Group 39 from CIB, who focused on deconstruction (Storey, Chini, and Schultmann, 2008). This activity is often embedded within articles with the broadest scopes of C&D waste management, deconstruction practice, design for deconstruction, or equivalent, and within the more general theme of sustainable building.

Through the literature review process, a number of key literature areas have emerged, which has allowed for a thematic analysis of key factors. Literature referring to the reuse of building products, within the building and waste sectors was first investigated. This has led to the creation of three sections: ‘The Reuse of Building Products’, ‘Solid Waste Management’, and ‘Sustainable Building: A New Way of Thinking’. Academic literature usually emphasises the sourcing of salvaged products, and particularly expands on it within the topics of deconstruction and design for deconstruction, as a strategy to reduce waste production. This has generated the sections ‘Deconstruction’ and ‘Design for Reuse and Other Designs’ in this literature review. This literature review has later been completed with an explanation of design with salvaged products to account of its specificities, hence the section ‘Designing with Salvaged Products’.

The theories and arguments associated with the reuse of building products are usually the result of the interests and perceptions of the stakeholders involved in this topic. They are presented in the section ‘Stakeholders and Their Lack of Support to the Reuse of Building Products’. Furthermore, the case studies involving the salvaging and the reuse of building products usually refer to the economic and commercial aspects of these activities,
leading to the creation of the section ‘Economic Influence’. The reuse of building products must also give effect to legislation, explaining the creation of the section ‘Statutory Framework’.

Information gathered in this chapter is relevant to Objective Two which is to identify the barriers against and the opportunities for the effective reuse of products in the Dunedin building industry. These themes are consistent with the scope defined in Chapter One.

Within these themes, key concepts have been defined to set up the context of the reuse of building products. They have later been analysed under the light of the research topic to establish key findings. This means that although some themes, such as sustainable building, are broad, only similarities with the reuse of building products have been considered. The order of presentation of these themes in this chapter is shown clockwise in Figure 2.1:
2.1. The Reuse of Building Products

2.1.1. History

“Existing buildings are huge reservoirs of materials and components that can potentially be mined to provide much needed resources”

(Gorgolewski and Morettin, 2009, p. 105).

Although this quote dates from 2009, this activity has been relevant for thousands of years. Reusing building products is both a traditional activity and a substitution to the use of new products. In the past, the scarcity of products and the intensive labour needed to shape them encouraged their reuse. Testimonies date back to Egyptian times (Litchfield, 1983). Historical records reveal that Turkish people have recovered and reused building products since the middle of the fifteen century (Elias-Ozkan, 2002). Temples were deconstructed and churches erected using products from them on the land where they used to stand on (Willart, 1997). During the American settlement, building products were frequently reused because of their scarcity and for economic reasons (Litchfield, 1983). Gorgolewski (2008) considers that prosperity, progress, fashion, and the disposability of products have negatively influenced their recuperation, explaining the current wide use of new building products.

2.1.2. Academic Understanding of the Reuse of Building Products

Since the 2000s, a minority of academics researching on the efficient use of building products have exposed their interest in reusing building products. Their approach is uncombined as many have developed a definition for this activity. This section introduces and discusses the scope they give to this activity.

Definition of the Term ‘Reuse’

Different Interpretations of the Term ‘Reuse’

Academics have not produced a single accepted definition of the term ‘reuse’ for the building sector as they give the term different meanings. They usually present their interpretations according to the scope defined in their research. Examples are presented in the next table, Table 2.1.
### Table 2.1 - Table of the Different Reuses in Building (adapted from Gorgolewski, 2008, p. 178; Janssen and Hendriks, 2002, p. 1402; Paduart, et al., 2009, p. 19; Saleh and Chini, 2009, p. 30)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adaptive Reuse</strong></td>
<td>Relocation and/or reuse of an entire building</td>
<td>Building Reuse</td>
<td>Exclusion</td>
</tr>
<tr>
<td>Reuse the structure of the building as much as</td>
<td>Reuse of major parts of a building - renovation of</td>
<td>It revolves around repairing a building to accommodate a new use</td>
<td></td>
</tr>
<tr>
<td>possible</td>
<td>a building</td>
<td>rather than tearing it down.</td>
<td></td>
</tr>
<tr>
<td>Applies particularly to heritage buildings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suggests a refurbishment of the building</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Relocation</strong></td>
<td>Relocation and/or reuse of an entire building</td>
<td></td>
<td>Exclusion</td>
</tr>
<tr>
<td>Move most or all of an existing building to a new</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Component Reuse</strong></td>
<td>Reuse of components in a new building or elsewhere</td>
<td>Component Reuse</td>
<td>Inclusion</td>
</tr>
<tr>
<td>Use of materials recovered from a building subject to</td>
<td>in the same building</td>
<td>It requires maintaining the majority of the interior nonstructural</td>
<td></td>
</tr>
<tr>
<td>demolition into a new building</td>
<td></td>
<td>elements such as interior walls, doors, floor coverings, ceiling</td>
<td></td>
</tr>
<tr>
<td>Uncommon reuse, except for heritage elements</td>
<td></td>
<td>systems and so on to be used in a similar or different application</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>at the end of the building’s useful life.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reprocessing of components and materials into</td>
<td>Material Recycling (excluded from the scope of reuse)</td>
<td>Exclusion</td>
</tr>
<tr>
<td></td>
<td>new components - recycling of materials into new</td>
<td>Recyling consists of three different routes: down-cycling,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>materials</td>
<td>recycling, and up-cycling. Each one of these routes requires</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>energy inputs and result in waste and emissions depending on the</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>material itself.</td>
<td></td>
</tr>
</tbody>
</table>

The fifth line in Table 2.1 represents the recycling of building products, considered as a type of reuse. According to the previous table, Gorgolewski (2008) and Saleh and Chini (2009) exclude the recycling from the reuse of building products. However, it becomes clear, following the definitions of Paduart, et al. (2009) that these notions are sometimes treated as a same topic by building researchers. Hobbs (2011a) confirms that the absence of common language among academics to differentiate the reuse from the recycling of building products is creating confusion for academics discussing this topic.
An Interpretation to Differentiate the Reuse of Materials from their Recycling

Two definitions of ‘reused materials’ and ‘recycled materials’ by the Building Research Establishment are presented to distinguish reuse from recycling. According to this institution, reused materials are “materials that can be extracted from the waste stream and used again without further processing, or with only minor processing, that does not alter the nature of the material (e.g. cleaning, cutting, fixing to other materials)” (BRE Global Ltd, 2011, p. 255). Recycled materials are “materials diverted from the pre-consumer and/or post-consumer waste streams that require significant processing before they can be used again” (BRE Global Ltd, 2011, p. 255).

Recycling building materials implies that salvaged resources are processed in such a way that they lose their initial physical properties, contrary to their reuse (Public Architecture, 2010). When recycled, these products can be mixed with primary and/or secondary ones to produce a new material. For instance, concrete can be crushed down to form ‘new’ secondary aggregates that are optionally going to be mixed with traditionally processed aggregates to create a concrete slab (Rao, Jha, and Misra, 2007). Another example of recycling is when salvaged timber is recycled into chipboard (te Dorsthorst and Kowalczyk, 2005). As this research is based on the reuse of building products, their recycling is excluded from the scope of this study.

Definition of ‘Building Products’

Although the terms ‘construction’ and ‘building’ are often used one for another, they have a slightly different meaning. Professor Bon differentiates the construction from the building sector by explaining that the first sector relates to “both buildings and civil engineering structures” (1991, p. 3). As the topic of this research is the reuse of products in the building industry, materials from civil engineering are excluded from the research scope, as well as the reuse of building products in civil engineering structures.

Vocabulary referring to building products in the literature is diverse. As presented in Table 2.1, the Delft’s Ladder differentiates building elements from building components. Patterson explains that “materials may be assembled into building components” (1990, p. 12). Saleh and Chini (2009) provide a definition for each degree of building products assembly. Their finding is displayed in the following table, Table 2.2:
Table 2.2 – Definitions of Building Products (from Saleh and Chini, 2009, p. 32)

<table>
<thead>
<tr>
<th>Product</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building elements</td>
<td>Major building parts e.g. roofs, vertical structures, walls, floors, or foundations.</td>
</tr>
<tr>
<td>Building components</td>
<td>Next level of nonstructural building parts such as interior walls, doors, floor coverings and ceiling systems.</td>
</tr>
<tr>
<td>Building sub-components</td>
<td>Breakdown of components into their smaller pieces such as the duct systems of heating and cooling systems, the hardware for a door unit, or the sash of a window unit.</td>
</tr>
<tr>
<td>Building materials</td>
<td>Constituent materials from which all other elements, components, and subcomponents are made, such as plastics, metals, wood, and masonry.</td>
</tr>
</tbody>
</table>

To simplify the vocabulary used in this study, the researcher employs the term ‘building product’ to refer to any recoverable building element, component, sub-component, or material.

**Summary of section 2.1**: Reusing building products has always existed and was in the past a current practice for many civilisations, due to their scarcity and the labour-intensiveness they required, resulting in their high value. Recently, this activity has been reconsidered by academics to gain on sustainability in the building industry. However, their scope and interpretations of this concept vary, bringing difficulties to provide a common understanding of this concept.

Four significant concepts associated with the reuse of building products are analysed in the next four sections. First, reusing building products is an alternative to their waste disposal and a C&D waste solid management option. This aspect is discussed in the section ‘Solid Waste Management’, where the need for waste diversion from landfills is emphasised. Some methods to minimise C&D waste production are then examined in the following sections: deconstruction, design for reuse or similar design, and designing with salvaged products.


2.2. Solid Waste Management

Before being reused, a building product has been used in another place. Two scenarios are possible when it is released: either its owner intends to value and exploit it, or he/she plans to discard it. In the last circumstance, the product becomes a C&D waste. However, if, for any reason, it is salvaged, reclaimed, or recovered, the status of the product changes as it reverts to a building product for its new owner (Hendricks and Janssen, 2004). This consideration of a C&D waste as a valuable product is particularly depicted in C&D waste hierarchies, listing C&D waste minimisation and management options (Janssen and Hendriks, 2002). Therefore, the notions of waste, C&D waste, and C&D waste management and minimisation strategies, are analysed in the next sections to emphasise the significance of reusing building products in C&D waste management.

2.2.1. Construction and Demolition Waste

C&D waste is the main waste stream accounting worldwide for between 30 to 50 percent of total solid waste production (Hobbs, 2011b; Storey, 2008). It is therefore worthwhile to be better informed on this category of waste to understand its significance and develop a coherent and reflective waste minimisation strategy (Hobbs, 2011b).

Despite the agreement in the literature that C&D waste amounts for a significant part of the total amount of waste worldwide, several academics concede a lack of reliable data on this waste stream. The following table, Table 2.3, lists diverse reasons explaining the estimations of C&D waste production.
Table 2.3 – Reasons for Estimations of C&D Waste Production in Various Countries

<table>
<thead>
<tr>
<th>Reason(s) for inaccuracy</th>
<th>Country</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few local surveys</td>
<td>Canada</td>
<td>Gorgolewski, 2011</td>
</tr>
<tr>
<td></td>
<td>Norway</td>
<td>Nordby, 2011</td>
</tr>
<tr>
<td>Absence of method to evaluate the amount of waste</td>
<td>Israel</td>
<td>Peled, 2011</td>
</tr>
<tr>
<td>Estimations from past data on the construction, demolition, and rehabilitation of some buildings</td>
<td>Norway</td>
<td>Nordby, 2011</td>
</tr>
<tr>
<td>National statistics are based on the waste treated by the waste management industry</td>
<td>Canada</td>
<td>Gorgolewski, 2011</td>
</tr>
<tr>
<td></td>
<td>Israel</td>
<td>Peled, 2011</td>
</tr>
<tr>
<td>Lack of common definition nationwide</td>
<td>Canada</td>
<td>Gorgolewski, 2011</td>
</tr>
<tr>
<td>Use of statistics on waste data per person or on data provided by the waste industry</td>
<td>Israel</td>
<td>Peled, 2011</td>
</tr>
<tr>
<td>No obligation to collect C&amp;D waste quantities</td>
<td>Switzerland</td>
<td>Treyer and Wallbaum, 2011</td>
</tr>
<tr>
<td>Lack of compliance from the waste industry with the legislation</td>
<td>Hungary</td>
<td>Bio Intelligence Service, 2011</td>
</tr>
</tbody>
</table>

The estimation of C&D waste production provides unreliable data and obstructions the significance of this type of waste in the total waste production (Yost and Halstead, 1996). This situation may prevent incentives to be adopted for this waste stream, including the development of a strategy to encourage the reuse of building products (Ministry for the Environment, 2011e). According to Table 2.3, some reasons for estimating national C&D waste production are associated with underperforming processes in the solid waste industry that are solvable, such as its lack of compliance with the legislation and the absence of a specific method to assess this stream.

2.2.2. Construction and Demolition Waste Management and Minimisation Strategies

Despite the lack of accuracy on C&D waste statistics, the acknowledgment of this waste stream as a significant contributor to waste production has driven the need to better manage it. C&D waste management and minimisation strategies are defined and ranked according to their environmental benefits. The evolution of this theory is presented in the following sections.
The Lansink’s Ladder

The Dutch have established at the end of the 1970s the ‘Lansink’s ladder’ to prioritise the actions necessary in C&D waste management (Janssen and Hendriks, 2002). The following figure, Figure 2.2, presents the C&D waste management and minimisation strategies adopted by their government, including the reuse of materials:

![Diagram of Lansink's Ladder]

Figure 2.2 – The Lansink’s Ladder Adopted by the Dutch Government at the End of the 1970s (from Janssen and Hendriks, 2002, p. 1401; Willart, 1997, p. 755)

This ladder aims to minimise C&D waste and value this resource as much as possible. However, it is simplistic as it does not include all the new processing modes to exploit C&D waste (Janssen and Hendriks, 2002). This hierarchy is also criticised for its top-down approach, as it prioritises the top of the ladder’s strategies to the ones below (te Dorsthorst and Kowalczyk, 2005). Further research, notably by the Delft’s University has improved and developed it to include other recovery opportunities available with the development of new technologies (Janssen and Hendriks, 2002).

The Delft’s Ladder

The ‘Delft’s Ladder’, depicted in Table 2.4, comprises ten waste strategies to exploit C&D waste, as opposed to the six strategies listed within the Lansink’s Ladder. Another advantage presented by te Dorsthorst and Kowalczyk (2005) is that this latest ladder is more adaptable; C&D waste opportunities are not strictly ranked but are selected following
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the results of calculations determining the best environmental option for each scenario. A positive point for the reuse of building products is that it appears as a C&D waste management option in these two ladders.

Table 2.4 - The Delft's Ladder (from Janssen and Hendriks, 2002, p. 1402)

<table>
<thead>
<tr>
<th>The Ten Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
</tr>
<tr>
<td>Reuse of Constructions</td>
</tr>
<tr>
<td>Reuse of Building Elements</td>
</tr>
<tr>
<td>Reuse of Materials</td>
</tr>
<tr>
<td>Useful Application as Residue</td>
</tr>
<tr>
<td>Immobilisation with Useful Applic</td>
</tr>
<tr>
<td>Immobilisation without Useful App</td>
</tr>
<tr>
<td>Incineration with Energy Generation</td>
</tr>
<tr>
<td>Incineration</td>
</tr>
<tr>
<td>Dumping</td>
</tr>
</tbody>
</table>

A definition of the C&D waste management possibilities listed in Figure 2.2 and Table 2.4 is provided in the next section.

**Definition of the Waste Management and Minimisation Strategies Detailed in the Lansink and Delft’s Ladder**

**Prevention**

This first step is necessary at the early stages of any project, when designing and conceptualising. It should involve strategies such as design for reuse or a similar design to allow a later exploitation of the building products (Saleh and Chini, 2009; te Dorsthorst and Kowalczyk, 2002).

**Reuse of construction**

Adaptability and flexibility are two essential characteristics to ensure a building’s complete reuse (Gorgolewski, 2008). As a consequence, vacant buildings can be adapted to be operative. Offices can be adapted into flats in city centres; it has been the case in New York, Hong Kong, London and Toronto (Heath, 2001; Langston, et al., 2008). Temporary buildings, such as tents and air-supported structures used for trade fairs and special events,
are also an example of reused construction (Gorgolewski, 2008). Storey, et al. (2003) mention the relocation of prefabricated classrooms and houses as a reuse of construction.

Reuse of building elements and Reuse of materials
A definition of the terms building elements and materials is provided in section 2.1.2. This type of reuse is studied in the present research and is considered as a reuse of building products. A definition of these waste management strategies is provided in Chapter One. Recycling can also be considered under these options.

Useful application as residue
The C&D waste undergoes a process, Recycling is the operation allowing (the) materials to be processed and optionally mixed with other materials, either primary or secondary, to create new merchandise (BRE Global Ltd, 2011).

Immobilisation with or without useful application
These stages are generally for products containing pollutants (te Dorsthorst and Kowalczyk, 2002). The immobilisation is undertaken to make sure that they do not leak and do not release pollution into the environment.

Incineration with or without energy recovery
This operation is carried out when the products have no residual value, whether they are highly pollutant or harmless to human health and the environment. The last possible environmental resort is an energy recovery. It involves burning the products if they are highly inflammable. Incineration, although reducing the volume of waste to landfill, is controversial because of the air pollution it generates (Damien, 2006).

Dumping
This waste treatment is the less efficient one. Products do not provide any benefit for human activity and consume space in a landfill (Damien, 2006). This category is similar to the ‘Disposal’ application on the Lansink’s Ladder.

Towards the Eindhoven’s Ladder?
The Delft’s Ladder is criticised by some researchers from the Eindhoven University, in the Netherlands. According to them, it does not contain an ‘integral chain management’, with the visualisation of a closed material loop linking C&D waste to the production of new
building products, representing the recovery and the exploitation of C&D waste (van der Meer, Pereira Roders, and Erkelens, 2006). These researchers have developed an Eindhoven’s Ladder, which representation looks more complete, but also more complicated. This ladder is provided in Appendix A.

**Summary of section 2.2:** The reuse of building products is acknowledged as a C&D waste management and minimisation option in the ladders listing them. These ladders have increasingly evolved to advise the adoption of the best environmental option resulting of a study of the C&D waste. Despite this progress in C&D waste management, this waste stream is insufficiently documented worldwide, although there is a consensus that it accounts for a great share of total waste production. This lack of accuracy on its statistics possibly means that its significance is underestimated, resulting in a lack of interest for C&D waste management and being a reason for the absence of a better promotion of the reuse of building products as an option to minimise this waste stream.

The three next sections introduce some methods to minimise C&D waste and provide for reusable salvaged building products. The first section relates to the concept of deconstruction, as opposed to demolition, to maximise the recovery of building products at the end of a building’s life. The two other methods analysed are related to the designs of buildings minimising C&D waste production.

### 2.3. Deconstruction

#### 2.3.1. A Variety of Similar Concepts

The terms ‘demolition’, ‘deconstruction’, and ‘disassembly’ all refer to an activity occurring at the end of a building’s life. Although the notions are quite similar, their outcomes are different, as the following definitions reveal:

- **Disassembly** – taking apart components without damaging, but not necessarily to reuse them.
- **Demolition** – a term for both the name of the industry and a process of intentional destruction.
- **Deconstruction** – similar to disassembly but with thoughts towards reusing the components (Hobbs and Hurley, 2001, p. 98).
To simplify, the notion of demolition refers to the rapid process of destruction whereas the notion of deconstruction is bound with a more meticulous work to salvage and value as many products as possible. This last point is confirmed by the definition provided by Storey, et al. for the New Zealand context: “deconstruction is the systematic dismantling and recovery of construction materials from a structure at the end of a building’s life. It is an alternative to traditional demolition where virtually all materials end up in a landfill” (2003, p. 2).

2.3.2. Subcategories of Deconstruction

Chini and Bruening consider that: “not all deconstruction projects involve complete disassembly of the building” (2003, p. 5). The deconstruction process can be complete or partial, depending on the value of salvageable products. In the case of a partial deconstruction, which is also called soft-stripping, valuable products are retrieved either for a future reuse or recycling, or because of their hazardous properties (Guy, Shell, and Homsley, 2002).

2.3.3. An Increasing Interest in Deconstruction

Many countries have a growing interest in deconstruction and research ways to maximise products recovery (Chini, 2005). A selection of examples is provided to illustrate the variety of research in this field. Germany and France have developed some deconstruction assessment tools to assist in an efficient deconstruction (Schultmann, 2005). Japan has researched the barriers to deconstruction by identifying some building design unfavourable to it (Nakajima and Koga, 2009). Some New Zealand demolition contractors have developed equipments to facilitate deconstruction (Storey and Keane, 2008). Two researchers from the University of Florida, among many other researchers, have investigated the economy of deconstruction (Chini and Bruening, 2005).

2.3.4. Examples of Building Products Recovered Following Deconstruction

A variety of building products are recovered during deconstruction. According to Kernan (2002), the most recovered building products in Canada are timber products such as beams, joists, trusses, doors, and decking materials. According to a Riverdale case study in the United States of America on the deconstruction of a residential unit, the items which did
not require a significant amount of labour to be retrieved were: gutters and rakes, piping and wiring flooring, plumbing fixtures and appliances, windows, and joinery (NAHBRC, 1997, p. 20). Besides, hazardous products, such as those containing asbestos and lead, are recovered to avoid any future pollution (NAHBRC, 1997).

**Summary of section 2.3:** The choice of the method to apply at the end of a building’s life influences the amount of products recovered. Deconstruction, a growing process researched worldwide, allows a significant recovery of what would otherwise become C&D waste. By seeking the preservation of salvaged products, deconstruction encourages their reuse.

The next section introduces the design for reuse or other similar designs to maximise the recovery of building products at the end of a building’s life and to anticipate their supply for a future reuse.

### 2.4. Design for Reuse and Other Similar Designs

Nakajima and Koja (2009) have found that some designs are unfavourable to deconstruction and therefore to a future reuse of building products. Paduart, *et al.* explain that common building design is too traditional and does not anticipate the future of a building: “the main problem regarding adaptability, disassembly and reuse is the fact that over the past decades designers conceived buildings as being fixed and permanent” (2009, p. 19). Academics usually agree with this affirmation as many support the adoption of specific designs to prepare for building alterations at their end of life (Saleh and Chini, 2009; te Dorsthorst and Kowalczyk, 2002).

#### 2.4.1. A Diversity of Designs

Many designs take into account the end of buildings’ life. Some of these environmental designs are defined in the following table, Table 2.5:
Table 2.5 - Terms and Definitions Related to Design for Reuse

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design for Adaptive Reuse</td>
<td>Designing for adaptive reuse requires designing for the recovery of the majority of the building’s components i.e. exterior walls, roofs, foundations, decking, exterior skin and frames and so on. It also requires designing for recovery of the majority of the interior non-structural elements i.e. interior walls, doors, floor coverings, ceiling systems and so on. In short, designing for building adaptive reuse should ideally expose the building’s structure to minor changes while undergoing major renovations and modifications. (Saleh and Chini, 2009, p. 30)</td>
</tr>
<tr>
<td>Design for Disassembly</td>
<td>To re-use building elements, a construction should be designed to disassemble these elements at the demolition stage. This DFD (Design for Disassembly) also makes constructions more adaptable. (te Dorsthorst and Kowalczyk, 2005, p. 175)</td>
</tr>
<tr>
<td>Design for Reuse</td>
<td>Designing for reuse after deconstruction will require that the element can be removed from the building with as little damage as possible. A suitable deconstruction sequence must be planned appropriate to the time when the component is likely to be removed. (Hurley and Hobbs, 2005, p. 333)</td>
</tr>
<tr>
<td>Design for Deconstruction</td>
<td>The overall objective of designing for deconstruction is to reduce the environmental impacts such as pollution from the demolition of buildings, and to increase the stream of used and recycled building materials through designing for the recovery and the eventual reprocessing of building materials. The idea is to employ design practices that facilitate the recovery of materials with high capacity for recycling and reuse in order to selectively and systematically deconstruct buildings that would otherwise be completely or partially demolished at the end of their useful lives. (Saleh and Chini, 2009, p. 33)</td>
</tr>
</tbody>
</table>

The terms presented in Table 2.5 have a slightly different meaning but refer to similar concepts. These designs are used to prevent the production of C&D waste at the alteration and end of a building’s life. These definitions also suggest that the design occurs at an early stage of a building’s life. As Paduart, et al. explain: “possible change over time is therefore being incorporated from the first stages of conception of a building and its components” (2009, p. 19). Within these environmental designs is the design for reuse of building products. Its concepts are detailed in the next section.
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2.4.2. Concepts of Design for Reuse

Design for reuse consists in a diversity of strategies which can be summarised with the concepts of anticipation, and information, as presented in the next sections.

Anticipating the Choice of Building Products

As the definitions in the previous sections illustrate, anticipation should be an approach adopted for any environmental building design. Deconstruction should be made as easy as possible to recover and protect salvageable building products. This means that the designer has to choose carefully the building products to be used. Three products characteristics are analysed in the next sections.

Characteristics of the Products

Many criteria are considered to select reusable building products. Preference is on products with a long lifespan or a lifespan longer than the lifespan of the building (Sunke and Schultmann, 2009; te Dorsthorst and Kowalczyk, 2005). As explained in section 2.2, non-hazardous products need to be favoured for health and safety reasons (Kibert, 2008). In addition, Nakajima and Koga (2009) explain that some products used for insulation are loose and therefore difficult to handle and contain, complicating their recovery.

The Economic Character of Products

Researchers agree on anticipating the value of the products released following deconstruction. Saleh and Chini advise choosing building products which will maximise profits at the end of a building’s life: “designers can promote designing for deconstruction by choosing materials that have high quality and will have a high dollar amount return when recovered in the future” (Saleh and Chini, 2009, p. 32). This theory tallies with the observation of Storey, et al. (2005) that pine wood is not recovered in New Zealand due to its low value.

Towards Multifunctional and Standardised Products

To enhance the opportunities of building products reuse, some academics recommend them to be multifunctional and standardised. As Paduart, et al. explain: “to enlarge the possibilities of reuse of these components it is of major importance to design these components from a non-specific and non-contextual approach, and to focus on systematisation and standardisation of form and dimension” (2009, p. 21). This
multifunctional character allows the product, once recovered, to be easily reused for a multitude of purposes. In addition, more and more academics recommend the standardisation of building products (Hurley and Hobbs, 2005; Sunke and Schultmann, 2009). In this objective, some Norwegian researchers have conceived a flexible building component in the form of a cubicle, which can be made out of salvaged timber (Nordby, Wigum, and Berge, 2009).

**Anticipating the Choice of Design and Connections**
Connections can be stronger than the building products, resulting in their damage when disconnected. This is the case with bricks laid with cement mortar or when staples, nails or sealants connect building products (Nakajima *et al.*, 2005; Nordby *et al.*, 2009). Academics consequently recommend employing demountable connections, such as limestone mortar, and bolts (Nordby *et al.*, 2009; te Dorsthorst and Kowalczyk, 2005).

The installation order of building products also has to be anticipated to ease deconstruction. Prescribing the separation of products according to their lifespan in the building design facilitate their recovery (Saleh and Chini, 2009). In other words, the shortest lifespan products should be easily reachable without damaging the long lifespan products.

**Information**
Researchers agree that building products and their previous employment need to be identified prior to reuse. Gorgolewski (2008), in his study on reuse of building products in Canada, has found that possessing the plans of an old building before deconstruction has helped to know the quality of recovered building products and label the ones to be sold. More generally, Saleh and Chini (2009) advise designers to document the quality of the products and the diverse connections used in a building project to facilitate their deconstruction, while Kibert recommends the provision of a “standard and permanent identification of material types” to facilitate their reuse (2008, p. 259).

**Summary of section 2.4:** Design for reuse requires the adoption of a new approach to building to make it more sustainable. It is a significant stage preparing for the future recovery and reuse of products at the building’s end of life, guided by some key concepts.
Chapter Two: Literature Review

Ignored in the past, this type of design is more and more considered by academics, calling for a revolution in the building industry.

Deconstruction and design for reuse are two methods anticipating the recovery of building products. These products can be reutilised in a building. In that case, a particular design is set up, with a process different from traditional design, as detailed in the following section.

2.5. Designing with Salvaged Products

Literature from the W115 focuses more on the design for reuse (or similar) rather than on the designs using salvaged products. Research on design with salvaged products usually comes from North America, although other countries are paying attention to it. The Vancouver Regional District has commissioned Kernan, an architect, to carry out research on the reuse of building products and to develop case studies. In 2002, the local authority published a report *Old to New - Design Guide Salvaged Building Materials in New Construction*, which is still a reference (Public Architecture, 2010). Gorgolewski, a researcher at Ryerson University, in Canada has also published two articles on the reuse of building products (Gorgolewski, 2008; Gorgolewski and Morettin, 2009). Moreover, the American Public Architecture Association has analysed 15 North American building projects involving the reuse of building products and emphasised the lessons learnt from each of these projects (Public Architecture, 2010). Storey (2002), from New Zealand, has also shared his findings following the renovation of an old villa with salvaged building products in a paper written for the Task Group 39 of CIB.

2.5.1. The Acceptance to Reuse Building Products

All the authors from the documents cited in the previous paragraph insist on the fact that the architect, the contractor, and the owner of the building have to agree on reusing building products to achieve a successful outcome. All these stakeholders have to accept and deal with the uncertainty of finding suitable salvaged building products and its consequences.

The Designers

The designers are the stakeholders directly affected by the reuse of building products. Salvaged products can be chosen prior to and/or during the construction phase (Kernan, 2002). Both situations have pros and cons: deciding on the products used in the design
stage allows the design phase to be completed rapidly whereas integrating unknown salvaged products at the construction stage allows using more of them (Kernan, 2002). Whichever approach is chosen, the designers usually have to spend more time than in traditional projects to accommodate the design with salvaged products and be creative and flexible enough to modify it if needed (Gorgolewski and Morettin, 2009).

**The Contractors**

The contractors have to accept the possibility that they may be held up with delays during the project (Storey, 2002). Reusing building products requires additional work to clean, repair, repaint or resize products (Kernan, 2002). Another hindrance is that reusing building products may require builders to reconnect with traditional building practices as they will have to remake building components (Kernan, 2002). As an example, Kernan (2002) explains that for one of his case studies, builders had to recreate windows.

The reuse of building products also interfere with the tasks of contractors. Storey (2002) and Gorgolewski (2008) observe that contractors are not always complying with the specifications on this activity. To remediate this issue, these two academics recommend designers to work with contractors familiar with this process or to educate them to be able to follow the plans.

**The Building Owners**

The owners of a building have to support the project that is reusing building products. They must be prepared to invest in salvaged products early in the project, as opposed to traditional practice (Gorgolewski, 2008). They also may have to wait longer to get the building finished and be willing to make concessions over the availability and quality of the salvaged products used (Kernan, 2002; Public Architecture, 2010). For example, a reusable building product can have visual defects, such as dents on a metal doorframe (Kernan, 2002). It is up to the owners to choose to buy this product and to install it ‘as is’ or to get it upgraded so that it meets their expectations.
2.5.2. The Importance of the Specifications and the Contract

Specifications and contract are the key instruments guaranteeing that every stakeholder involved in the reuse of building products complies with what has been agreed. Literature tallies with the specification of the role and responsibilities of everyone, including the indication of the person responsible for sourcing salvaged products (Gorgolewski and Morettin, 2009). If the building owner does not supply them, an agreement must be reached between the owner and the person sourcing these products to determine the quality sought (Kernan, 2002). In addition, some authors consider that a clear goal has to be set up for the percentage of products reused to avoid new products being specified (Kernan, 2002; Storey, 2002).

2.5.3. The Acquisition of Salvaged Building Products

Origin of Salvaged Building Products
Salvaged building products have diverse origins. They can be recovered from an on-site building, either altered or deconstructed (Storey, 2002). Gorgolewski (2008) observes that in this scenario, their quality can be known early through the specifications and drawings of the building, in accordance with the concept of information retained, as detailed in section 2.4. Salvaged products can also be off-site products. In this case, the easier situation for the designer is to get a supply of labelled products from an off-site building subject to deconstruction (Gorgolewski, 2008). When off-site, building products can be bought in several places, as detailed in the next section.

The Market of Salvaged Building Products
A variety of stakeholders lead the market in salvaged building products, multiplying the number of supplying platforms. This market is managed, depending on the countries concerned, by charitable organisations, demolition contractors, and salvage dealers (Mattu, 2008). At the same time, building trade people can sell them as well as local neighbourhood communities during garage sales (Litchfield, 1983). This market can be unregulated, and sometimes not declared, as is the case in Turkey, meaning that there is an absence of accurate information on it, and on the price of salvaged building products (Elias-Ozkan, 2002).
A Different Way of Acquiring Building Products

Acquiring salvaged building products is a significant part of a building project involving their reuse. Four stages are acknowledged for selecting salvaged products. The person in charge of sourcing them has to “identify, locate, inspect, and choose appropriate components” (Gorgolewski, 2008, p. 180). This person can be the owner, the designer, or the contractor, although some professionals are now specialised in sourcing them (Gorgolewski and Morettin, 2009; Kernan, 2002).

Acquiring salvaged building products can be complex. Gorgolewski observes that there is a need “to coordinate demand with supply” (2008, p. 179). Contrary to new building products, the salvaged ones are not, as Gorgolewski says, “readily available from stock” (2008, p. 179). They are also available in limited quantities (Kernan, 2002). This means that time is usually required to obtain salvaged building products and that their acquisition should be systematic to avoid them being sold to other interested parties (Gorgolewski and Morettin, 2009). An early purchase has the advantage to avoid further design work later in the project, but it may be inconvenient for the building owners to store these products at their expense (Gorgolewski, 2008).

2.5.4. The Certification of Salvaged Products

Salvaged products must be in a good condition to be reused. Grading salvaged products can be necessary to ensure their quality and be essential prior to obtain a building consent (Kernan, 2002). Good practice requires the designer to explain how this process is forecast in the contract (Gorgolewski and Morettin, 2009). X rays tests, the involvement of a professional wood grader, a structural engineer or the visual certification by the design team are some of the options available to certify salvaged building products (Gorgolewski, 2008; Kernan, 2002; Storey, 2002).

2.5.5. A New Design Process

Building researchers and architects agree that designing with salvaged products is more complex and demanding than adopting a traditional approach. This choice needs to be made early in the project, similarly to design for reuse (Public Architecture, 2010). The pre-design must be flexible, including a range of dimensions, rather than fixed measurements (Kernan, 2002). The uncertainty of salvaged products supply also implies
that designers have to be adaptable in the choice of products as their availability for a specific purpose is limited (Kernan, 2002). Using salvaged products also implies a mix use of old and new products, resulting in the need for a design that prepares and allows for a ‘visual coherence’ as well as a sound structure of the building (Storey, 2002, p.102). As a consequence, more time is usually required for this type of building projects as opposed to traditional design, especially if the products used are not selected at an early stage of the conception (Kernan, 2002).

2.5.6. A New Network

Designing with salvaged products revolutionises the way to source them as traditional markets do not supply them. The North American literature highlights that this design requires the development of a new network. As Gorgolewski and Morettin explain, “traditional relationships… may not be best suited to maximise material reuse” (2009, p. 106). The building industry has to develop contacts with the demolition and salvaging industries (Public Architecture, 2010). Gorgolewski and Morettin (2009) emphasise that the establishment of such a network will benefit the building industry as it will be able to pre-order some products and have them booked if they become available later.

Summary of section 2.5: Designing with salvaged products is a revolutionary step for the building industry, requiring the acceptance of all the stakeholders to be a success. Many changes to traditional practice are necessary to achieve it, necessitating a greater involvement from the building industry. They involve the acquisition of salvaged products, their certification, and their integration in a building project. Besides, reusing building products entails a review of contracts and specifications, as well as the creation of a new professional network.

The next section presents the stakeholders involved in the reuse of building products and their understanding of the concept.

2.6. Stakeholders and their Lack of Support to the Reuse of Building Products

Authors of the W115 usually tend to skip the significant role of the individual stakeholders for the efficient use of building products, by focussing on big organisations, whether government or the building industry, as a whole. W115 usually assess the involvement of
society through the relevant legislation and the integration of this activity within the scope of green building rating tools (Gorgolewski, 2011; Nakajima, 2011). In their publications, this social dimension of the reuse of building products is embedded within guidance documents and exemplars. North American authors writing specifically on design with salvaged products have another interpretation of this social dimension, focusing on the individuals involved in a building project with such activity. This section introduces the fact that a multitude of stakeholders, not especially supporting the reuse of building products, is involved or susceptible to be involved in this activity.

2.6.1. A Multitude of Stakeholders with Different Interests

Reusing building products is the result of a supply chain involving the demolition, waste and building industries. These industries include different ranges of professionals, not always aiming for the same outcomes, as presented in the following sections.

The Demolition and Waste Industries

The role of the demolition industry is to destruct buildings. Specifications from the client usually stipulate that the work has to be done as fast as possible, conflicting with a deconstruction process (Gorgolewski and Morettin, 2009). This means that the recovery of building products is often ignored by the client. As the reuse of salvaged products is a waste minimisation and management option, it involves waste managers, and landfill operators (Janssen and Hendriks, 2002). These stakeholders can have opposing objectives, as waste managers base their efforts on reducing the amount of waste disposed, including the C&D waste stream, whereas landfill operators make profit when receiving as much waste as possible (Bio Intelligence Service, 2011).

The Building Industry

The building industry is diverse as it encompasses many professionals with different backgrounds, not counting the owner or the client commissioning the project (Gorgolewski, 2008; Storey, 2002). It is implicated in reusing building products as a whole because it has a role to play in its commissioning, in certifying the properties of the products, and in carrying out the building work (Kernan, 2002). Although the common interest of designers, architects, structural engineers, contractors, developers, building consent officers, professors, researchers and builders is the built environment, they approach it from different perspectives. As detailed in section 2.5.1, conflicts can arise
between designers/architects and their contractors on reusing building products as it is labour-intensive. Some academics also attest a lack of communication and co-operation between building corporate associations of building professionals, complicating their agreement to reuse building products (Koskela, 2008; Warnock, 2007).

**The Government**

Governments are stakeholders involved in the reuse of building products as they usually have government organisations specialising in buildings and waste management (Gorgolewski, 2011). They are active through the development of legislation and regulations relevant to the reuse of building products (as developed in section 2.8). Therefore, legislators, executive parties, and stakeholders who have to comply with these documents are likely to be stakeholders of this activity. The multiplicity of responsibilities for the government creates some conflicts; for example, the goal of building control authorities is to get sound and safe buildings, potentially challenging the use of salvaged products in buildings whereas waste managers promote a diversion of C&D waste, and can encourage building products to be reused (Janssen and Hendriks, 2002; Kernan, 2002).

### 2.6.2. The Lack of Encouragement from the Building Industry to Reuse Building Products

As stated in section 2.6.1, the building industry plays a significant role in reusing building products as it carries out the building work, although it generally does not support this activity. This section presents two arguments corroborating this statement.

**A Traditional Mindset**

Traditional practices in the building industry are rooted in their habits. There is a general agreement in the literature that building professionals are conservative and supportive of traditional practices which are economically-driven and seek time-efficiency (Gorgolewski, 2008; King and King, 2005). Gorgolewski considers that reusing building products, where time delays might occur and additional work is required, is consequently an ‘unfamiliar challenge’ for this community, explaining their resistance to it (2008, p.182). In addition, designers fear an additional risk when prescribing salvaged products (Gorgolewski, 2008). This conservative character of the industry is believed to prevent
innovation and risks taking, explaining why a global green revolution has not happened yet in building (King and King, 2005).

Bio Intelligence (2011), Kernan (2002), and Macozama (2001) identify a lack of education and training, a lack of awareness, and a lack of willingness from the building community to use salvaged products, in Hungary, Canada, and South Africa. The same situation is occurring in New Zealand, according to Storey (2002). Following a case study, this author reports “the indifference of the contractors to resource issues and their unwillingness to try new ideas” (Storey, 2002, p. 109).

The Lack of Information Available to Reuse Building Products
Reusing building products is not a main stream activity in the building industry and there is a lack of information and guidance for designers on it (Public Architecture, 2010). This lack of information results in either prejudice or uncertainty. Such prejudice is usually negative: “at present, in Canada the perceived difficulties inherent in the incorporation of reclaimed materials into new buildings often discourage clients and designers from embracing reuse unless it is for principle rather than financial reasons” (Gorgolewski and Morettin, 2009, p. 105).

The lack of information on reusing building products is also an impediment for building owners asking advice of building professionals. If this situation happens, building professionals are unable to answer questions such as: how safe is a reusable building product? What is the quality of a recovered product compared with a new one? Is a reusable building product identical to a new one? Does a reused product have a higher ecological footprint than a new one? Is reusing building products an environmentally-friendly practice or is it green-washing? How much does it cost? (Hendricks and Janssen, 2004; Macozama, 2001).

Summary of section 2.6: A multitude of stakeholders can be involved in reusing building products. However, this activity is uncommon and insufficiently documented. As this is not their core activity and as most of these stakeholders are not aware or educated on it, they do not promote it. Perceptions on salvaged products are usually negative and many questions remain unanswered, showing that there is a need to fill in this gap.

The next section details the economic influence of reusing building products.
2.7. Economic Influence

The researcher has identified three major aspects influencing the reuse of building products economically. The first one is the value associated with the building products released from an existing building. The second aspect is their cost, while the third aspect is the additional costs they incur, such as the cost of labour. These aspects are presented in the following sections.

2.7.1. The Residual Value of Building Products

Humphries, in one of Storey’s conference papers, stresses that it can be “uneconomic, impractical, and logistically impossible to perpetually renew” existing office buildings (2007, p. 164). This statement suggests that every building has an end of life. Despite the negative aspect of this observation, buildings are a source of products immobilised into a strong structure (Gorgolewski and Morettin, 2009). Once released, they have the opportunity to be reutilised, and are therefore valuable. In addition, salvaging these products decreases the cost of deconstruction (Gorgolewski, 2008; NAHBRC, 1997; Pun, Liu, and Langston, 2006). Some researchers have even found that deconstruction can be more cost-effective than demolition (Crowther, 2005).

2.7.2. The Cost of Salvaged Products

There is a lack of information in the literature on the cost of salvaged building products. This can be explained by the fact that the salvaged yards are not mainstream retailing shops (as detailed in section 2.5) and because the price of second-hand building products is variable, depending on their characteristics. Saleh and Chini (2009) consider that the significance of the market of salvaged products influences their price, while Sunke and Schultmann (2009) believe that their availability is another influential parameter. Nonetheless, according to Kernan’s case studies (2002) and Gorgolewski and Morettin’s (2009) survey on building products reuse in Canada, salvaged products are usually cheaper than new ones.
2.7.3. Additional Costs when Reusing Building Products

Reusing building products is not restricted to the cost of salvaged products. Innovation and the need to upskill stakeholders, the increased labour to carry-out a more demanding building work, the certification of salvaged products, delays, and uncertainties generate additional costs. These expenses are analysed in the next sections.

Innovation

Innovation, as opposed to traditional practice, implies uncertainty, with likely longer and more complex designs and administrative processes, especially if a specific framework has not been defined for it (BRE Global Ltd, 2011). This is the case with the reuse of building products. The building industry often lacks skills and experience with this activity (Kernan, 2002; Public Architecture, 2010). This means that designers engaged in reusing products have to research and gather information on this activity, adding to the cost of the project (Kernan, 2002).

Labour Cost

Labour cost is usually increased when reusing building products (Gorgolewski, 2008; Guy, Shell, and Homsley, 2002). Even with professionals used to reusing building products, designing with salvaged products requires additional work for designers (Gorgolewski, 2008). In addition, sourcing products can be time-consuming, increasing the cost of the project if the contractor is in charge of this task. The cost of labour for builders also increases if they have to resize or restore some of the salvaged products (Kernan, 2002). Gorgolewski (2008) indicates that using salvaged building products is not necessarily economic, depending on the workload required for their restoration. The amount of time necessary to denail timber can be such that no saving is made by reusing it (Kernan, 2002).

Cost of Certification

A licence or a compliance document delivered by concerned authorities might be necessary prior to reuse building products (Hendricks and Janssen, 2004). An extra cost can incur to prove that these products meet health and safety or environmental requisites, or have sufficient structural properties. Besides, further costs are possible if the building products are from another country; in the case that ‘an export licence’ is required (Hendricks and Janssen, 2004, p. 318).
Cost of Delays and Uncertainties
By nature, the cost of reusing building products is difficult to predict. Conformism to traditional building practice offers more certainty on the completion of a building work, on time and on budget (Gorgolewski, 2008). Unexpected delays when reusing building products can add cost for the contractor (Kernan, 2002). Salvaged products can also be damaged during transport and when being stored, increasing the cost of the project (Gorgolewski, 2008). Storey, et al. (2005) share the story of native timber being irreversibly damaged following their exposure to the weather.

Summary of section 2.7: The cost associated with the recovery and the reuse of building products influences the offer and demand for this activity. Although salvaged building products are valuable and are sometimes valued, little information exists on their market price. It is indeed hard to give generalisations when selling places are unique and the salvaged components are so diverse. In addition, the cost of reusing building products includes the cost to purchase salvaged products, but also involves additional costs, sometimes underestimated such as labour or compliance cost. This provides uncertainty on the cost of a building project with salvaged products, being a deterrent for the client to request this activity. Despite these fears, projects in Canada have shown that reusing products is usually more cost-effective than using new ones.

The next section introduces the statutory framework associated with the reuse of building products.

2.8. Statutory Framework
2.8.1. Legislative and Regulatory Framework
International Legislation
Although they are not explicitly related to the reuse of building products, two international law texts have the opportunity to encourage this activity. The Rio Declaration on Environment and Development, adopted in 1992, although very broad in its concept, impacts on building activities because it advises the adoption of sustainable practices in every human activity and a better consumption of resource (Principles 3 and 8 of the Rio Declaration). In addition, the Habitat Agenda, adopted in 1996, in Istanbul, aims to improve the quality of human settlements and suggests many sustainable actions in this
regard (UN-Habitat, 1996). This document has a more direct impact on sustainable building than the Rio Declaration by encouraging intelligent socially-accepted settlements, a reduction of resource consumption, and a reduction in the amount of pollution released.

**National Legislation**

On a national basis, the reuse of building products is influenced by many types of legislation; the building law and land-use planning can offer a framework for sustainable building practices and consequently for reusing products (Hobbs, 2011b).

**Building Law**

Building laws have the potential to require certain qualities for the products used in buildings to ensure the safety of their users; and demolition and deconstruction laws are another set of laws which can influence the amount of products available for reuse (Bio Intelligence Service, 2011).

**Planning Law**

Planning laws can encourage the reuse of building products for preservation of heritage and of the streetscape. In some countries, such as Canada, some heritage strategies advocate a recovery of products in the event that a heritage building has to be demolished. The Aurora Architectural Salvage Program and the Regina’s Heritage Building Materials Strategy have been designed to encourage the salvaging of released heritage buildings’ products (Regina City Council, 2001; The Heritage Advisory Committee of Aurora, n.d.). Replacing faulty building products therefore allows preservation of the heritage and the identity of a heritage building. Planning laws also have the opportunity to develop a legislation specific to landfill sites and therefore have consequences on C&D waste management.

**Solid Waste Management Law**

C&D waste and landfill related laws can affect the reuse of products positively (Gorgolewski, 2011). Solid waste management laws usually promote a hierarchy of waste management options to avoid their landfilling (Bio Intelligence Service, 2011; Damien, 2006). According to a report written by Bio Intelligence Service, this type of legislation can increase the diversion of waste from landfill sites through measures such as disposal regulations, waste disposal levies, and mandatory monitoring and reporting.
Other Laws
Other laws, not explicitly referring to sustainable building and to C&D waste, can also support this activity. The implementation of an emission trading scheme, taxing the release of greenhouse gases has the power to make green practices more competitive (Pearce, 2006). The same effect is possible with the integration of the ‘polluter pays’ principle through ‘full-cost material pricing’ regulations (UNEP Industry and Environment, 2003, p. 5).

Contracts
Following international and national legislation, a third legislative aspect influencing the reuse of building products is the contract agreed between the client and the contractor for a building work (Bio Intelligence Service, 2011). This kind of voluntary agreement has been discussed in section 2.5.

2.8.2. The Lack of Statutory Framework for the Reuse of Building Products
Storey, et al. (2003) and Kibert (2003) agree that the building industry and their applicable legislation do not favour the reuse of building products. Storey, et al. (2003) state that the implementation of standards for building products implies that only new products can be used. In addition, Kibert (2003) considers that building codes often do not address this activity. Compliance with relevant authorities and insurances is not always guaranteed if salvaged products are used. If the practice is tolerated, the designer and the contractor are liable for reusing them (Gorgolewski, 2008). This position either hinders the reusing practice for the building industry or makes it illegal. Experts also talk of a lack of a grading system for reusable products and affirm that their certification is almost impossible (Kibert and Chini, 2000).

Summary of section 2.8: Reusing building products gives effect to two international legislations: the Rio Declaration and the Habitat Agenda. Furthermore, this activity is interdisciplinary and consequently has to comply with several types of national legislation. This can be both an opportunity and a barrier to a greater reuse of building products. Currently, this activity is often ignored in the legislation, meaning that the statutory framework is not favourable to it. The reuse of building products is also an activity that a client can request of a building professional, and this enquiry can be specified in the clause
of a contract linking these two parties, demonstrating the voluntary scheme associated with this activity.

A broader concept, sustainable building embraces the notions of C&D waste management, deconstruction, design for reuse and other similar designs, and design with salvaged products. To complete this literature review, the next section introduces the theme of sustainable building, relevant to the reuse of building products.

2.9. Sustainable Building: A New Way of Thinking

2.9.1. Impacts of the Building Industry on the Environment

The impacts on the environment for the duration of a building’s life have been studied for at least twenty years (Cole, 2005; Kibert, 2007). They result in global and local effects, “individual and collective, direct and indirect, impacts on the environment both present and future” (Norton and Skates, 2000, p.142). These effects are only presented in regard to the production and use of products.

Researchers agree that the building industry has a great impact on the environment, notably through its consumption of a large amount of natural resources and its significant waste production (Bio Intelligence Service, 2011; Gorgolewski, 2008). The production of buildings and materials necessitates space, energy, water, and physical resource, while greenhouse gas, dust, and waste are released (Kibert, 2008). Anink, Boonstra and Mak have estimated that for the Dutch context, “50% of material resources taken from nature are building-related. Over 50% of national [the Netherlands] waste production comes from the building sector. 40% of the energy consumption in Europe is building related” (1996, p. 8). This finding was specific to the year 1995. However, Storey (2008) considers these estimations for resource consumption and waste production to be typical on a worldwide scale.

The depletion of non-renewable resources has been established for decades. Authors are usually pessimistic; “with the accelerating rate of exploitation we are on the verge of bankruptcy in raw materials” (Berge and Henley, 2000, p. 5). Storey also predicts it in the near future: “the likelihood is that most conflicts in the 21st century will occur over resources and in particular resource security” (Storey, 2008, p. 8). Examples of indirect impacts of the consumption of raw materials needed for the construction are the
exploitation of quarries, petrol wells and the operation of massive deforestation (Berge and Henley, 2000; Kibert, 2008). These activities further alter locally aesthetic values and have a negative global effect.

Like the depletion of non-renewable resources, some impacts from building are irreversible. Because energy consumption is essential for the production of building products, they are considered to impact on climate change following the emission of greenhouse gas (Gorgolewski and Morettin, 2009; Norton and Skates, 2000). The impacts of waste following the end of buildings’ life are also significant, favouring the development of landfills (Gorgolewski, 2008; Kibert, 2003).

2.9.2. The Need for More Sustainability in Building

The adverse environmental effects of buildings and building products are multiple and contribute to the spread of worldwide environmental issues. Durmisevic (2009) believes that this situation is the result of the slow evolution of the traditional building concept. This model is now archaic as traditional building does not meet the needs of society anymore and has become a ‘burden’ (Durmisevic, 2009, p. 9). A revision of this approach is necessary following the acknowledgment of its impacts. Kernan predicts that: “architects will have to learn to be more ‘curators’ of the built environment rather than ‘creators’” (2002, p. 3). The concept of sustainable building was born out of these concerns.

2.9.3. Sustainable Building

Given the significant impacts on the environment of the building sector, changes in the approach to build are necessary to make it more environmentally sensitive. The next sections present the terms used to refer to the concept of sustainable building in the literature, its scope, and its evolution in meaning.

A Variety of Phraseologies

The concept of sustainable building is referred by a variety of phraseologies in the literature. For instance, the terms ‘sustainable construction’, ‘sustainable building’, ‘green building’, and ‘environmentally sustainable design’ are expressions used to refer to the same concept (Fullbrook, Jackson, and Finlay, 2005; Häkkinen and Belloni, 2011; Kibert, 2008; Shapiro, 2011). This multiplicity of words for the same theory are explained by the
fact that sustainable building is a recent concept and a worldwide consideration (Haselbach, 2010).

An Evolving Meaning
As stated in section 2.9.1, the impacts of building have been studied since at least the 1990s. The sustainable building concept has changed over the years from limiting the adverse environmental effects of buildings on the environment to their better adaptation within their ecosystem. According to Reed (2007) and Storey (2008), there is some awareness among the building industry that current sustainable buildings are not as environmental as they could be. These authors believe that the built environment is not integrated into the wider environment and that the sustainable approaches adopted in building are too fragmented. Kibert (2008) and Reed (2007) state that currently building professionals have a narrow-minded approach, based on technological possibilities, suggesting that enormous progress is possible to make the built environment more sustainable.

The Scope of Sustainable Building
The sustainable building concept has many meanings although a broad consensus has appeared in the literature to provide an ecological, social, economic and cultural dimension to it (Kibert, 2007; Warnock, 2007). Stakeholders of sustainable building, although they acknowledge its multiple facets, tend to put an emphasis on one of its dimensions. Some authors choose to study a particular sector of sustainable building, such as energy, which is the main focus on sustainable building (Kibert, 2007; Storey, 2008).

2.9.4. The Efficient Use of Building Products as a Sustainable Building Strategy
One of the objectives of sustainable building is to ensure an efficient use of building products (International Council for Research and Innovation in Building and Construction, 1999). Storey considers that ‘material resource depletion’ is a ‘tertiary priority’ for society, behind energy consumption and water deficiencies (2008, p. 8). W115, a group from the CIB is particularly active in research on the efficient use of building products. It is dedicated to Construction Materials Stewardship and its publications contain articles on deconstruction, design for deconstruction, supply driven architecture, and on the reuse of
buildings, building components, and materials. In 2006, it replaced Task Group 39, particularly concerned with deconstruction, to expand its area of research (Storey, Chini, and Schultmann, 2008). This working commission has the mission:

to drastically reduce the deployment and consumption of new, non-renewable construction materials, to replace non-renewable materials with renewable materials wherever possible, achieve equilibrium in the demand and production of renewable materials and ultimately to restore the renewable material resource base (Storey, Chini, and Schultmann, 2008, p. 6).

Evolution of the Concept of the Sustainable Use of Products
Like the concept of sustainable building, there has been an evolution in the sustainable use of products. There has been a shift, from a ‘linear’ to a ‘cyclic’ or ‘closed materials loop’ approach (Storey, 2008). Instead of being waste and buried, products should be given a new function or use. In other terms, this reasoning has evolved in eco-design, from a ‘cradle to grave’ to a ‘cradle to cradle’ approach (McDonough and Braungart, 2002). This evolution in concept results from a closer analysis of the relationships and functions in ecosystems, where dead matter is valued as it is decomposed to produce new nutrients for living beings. As McDonough, et al. highlight, in nature, ‘waste equals food’ (2003, p. 436A). The reuse of building products, by allowing materials to be re-employed, is a strategy in accordance with all these theories of sustainability and cyclic approaches, as it is a ‘restorative’ and ‘regenerative’ opportunity (Reed, 2007).

The Reuse of Building Products as a Sustainable Building Strategy
Reusing building products is a strategy for an efficient use of building products. It is a sustainable approach as it has environmental, social, cultural, and economic dimensions, as detailed in the next sections.

Environmental Value
As Gorgolewski and Morettin (2009) observe, a building is a reserve of resource, both of products and energy. As explained in Chapter One and in this section, reusing building products allows for conservation of materials, limits the amount of natural resource consumed and the production of C&D waste landfilled. The following paragraphs only introduce the energy consumption associated with the use of building products as this notion has not been introduced yet.
Chapter Two: Literature Review

The notion of ‘embodied energy’ is widely used to refer to the energetic investment in buildings. Many definitions exist, depending on their scope. Some academics refer to the whole energy necessary to create and bring the building materials to a site whereas others just consider the amount of energy necessary to produce them (Crowther, 2005; Saleh and Chini, 2009). A simple definition of embodied energy is: “the energy required to extract, process and manufacture, and transport a product. It is considered over a material’s life cycle from extraction to installation” (Bullen and Love, 2010, p. 215).

Reusing building products decreases significantly the amount of energy used in a building. Salvaged building products are usually considered to have a lower embodied energy than their new equivalents (Saleh and Chini, 2009). Thormark (2002), in a study analysing the part of embodied energy within the energy consumption of a building during its whole lifespan, concludes that the embodied energy can amount for up to 40% of the total amount of energy consumed by a low-energy building with a 50 year lifespan. A more recent study reaches the same conclusion: the embodied energy of building products amounts for a significant percentage of the total energy use of environmentally-friendly buildings (Itard, 2009). These findings highlight the need for a greater reuse of building products to decrease significantly the embodied energy of buildings. They also suggest that this activity could be adopted as a strategy to reduce a building’s energy consumption, which is currently the main focus of sustainable building.

**Social Value**

Storey, et al. (2003) suggest that reusing salvaged products can align with some indigenous cultures. The authors put forward that Māori have a concept of Kaitiakitangata or guardianship of the environment. By avoiding pollution being released into their environment, this activity is consistent with their values.

**Cultural Value**

At a time of globalisation, some communities have decided to value their heritage buildings and districts for cultural preservation and to develop their tourism (Knox, 2005). In this purpose and in the event of the demolition of a heritage building, an opportunity exists in recovering its constituents so that they are reused in other buildings (Litchfield, 1983; Public Architecture, 2010). According to Gorgolewski (2008), reused products usually have an historic value. The opportunity to reuse this heritage is notably critical to
maintain the present urban architecture style and maintain the identity of some cities, especially when the products used on the façades have become rare or impossible to supply (Litchfield, 1983).

**Economy**
The economical aspects of reusing building products have been covered in section 2.7.

### 2.9.5. The Implementation of Sustainable Building

This paragraph provides an overview of the criteria used to assess the sustainability of a building, and presents a variety of green building rating tools. It also analyses the contents of two of them to present how sustainable criteria related to the reuse of building products are accounted for.

#### Arbitrary Weighting of Performances

The priorities set up in sustainable building are the result of arbitrary choices. The criteria applied to certify the environmental performances of buildings are not similar around the world and vary according to the climate, the available alternatives, and the political will of countries to be more sustainable (Haselbach, 2010; Norton and Skates, 2000).

Another choice has to be made by researchers when weighing environmental impacts and comparing them together to define sustainable building, as they are usually not measured with the same unit (Cole, 1998; Kibert, 2008). For example, the material and energy consumptions of a building do not result in the same environmental impacts (Anink, Boonstra, and Mak, 1996). Material consumption results in non-renewable resource depletion whereas energy consumption can primarily generate air pollution. An illustration of the arbitrary choices and performances set up for sustainable building is demonstrated in green building rating tools, in Appendix B.

#### Green Building Rating Tools

**Purpose**

Green building rating tools or assessment tools assess the environmental effects at different stages of a building’s life: design, construction, and operation (Kibert, 2008). According to Kibert (2008), they are usually based on life cycle analysis methods. Land-use, proximity to public transport, energy and water consumption, the amount of pollution released, the
quality and quantity of materials consumed and released, and the quality of the indoor-
environment are often the criteria used in a voluntary process to understand a building’s footprint (Cole, 2005).

**A Multiplicity of Rating Tools**
There are many green building assessment tools (Haapio and Viitaniemi, 2008); usually countries, such as Canada, Japan, Singapore, and Switzerland develop their own assessment tool (Anggadjaja, Leong, and Hui, 2011; Gorgolewski, 2011; Nakajima, 2011; Treyer and Wallbaum, 2011). However, two green building assessment tools stand out on an international scale because of their popularity: the United Kingdom BREEAM, which stands for Building Research Establishment Environmental Assessment Method and the United States of America LEED, which stands for Leadership in Energy and Environmental Design (Lee and Burnett, 2008). These two assessment tools are used as examples in Appendix B to illustrate how rating tools measure the sustainability of buildings with the notions of reusing building products, C&D waste, deconstruction, design for reuse or similar, and design with salvaged products.

**A Variety of Rating Tools Reflecting the Occupancy of Buildings**
Green building rating tools usually have a declension of their methodology to take into account the different types of existing buildings. BREEAM and LEED have a specific checklist, with criteria matching a certain number of points, depending on the occupancy of the building considered. For example, there are LEED schemes for new constructions, homes, schools, and healthcare (Haselbach, 2010); and there is a BREEAM with calculations specific to industrial buildings, education, healthcare, offices, and multi-residential buildings (BRE Global Ltd, 2011).

**Summary of section 2.9:** The impacts of buildings and building products on the environment have been acknowledged and have given birth to the concept of sustainable building. This paradigm is broad and evolving, and often studied by focusing on one topic only. Sustainable building is usually interpreted in green building rating tools, where efforts to limit some selected environmental effects are attributed a certain amount of points. Consequently, reusing building products, a sustainable strategy to better use resources, is more or less considered in these assessment tools, suggesting that a greater weighting could promote it.
2.10. Summary

This chapter has established a theoretical framework for the present research, following the review and analysis of the relevant literature. The key theories and arguments relevant to the reuse of building products have been considered to identify the factors influencing this activity. The following themes have been identified: the reuse of building products, solid waste management, deconstruction, design for reuse or similar, design with salvaged products, stakeholders, economy, statutory framework, and sustainable building.

Within this analysis, salient points have emerged. Reusing building products is subject to diverse interpretations in literature and often confused with recycling materials. Academics agree that reusing building products is a sustainable alternative to their landfilling and helps reduce C&D waste production. Complementing the reuse of building products are two methods to maximise the recovery of products at the end of a building’s life: deconstruction and design for reuse. Like design for reuse, designing with salvaged products is different from traditional building design and requires some anticipation and additional work. These new designs notably call for a revolution in the building industry by adopting new practices, especially since the building industry does not particularly reuse building products. Another barrier for this activity is its cost. It is ambiguous to assess its economic benefits in comparison to building with new products. Indeed, salvaged products are said to be more reasonably priced than new products, but additional expenses can offset this gain. Regarding the legislation, reusing building products can be encouraged in many ways, in international and national legislation, and on a voluntary basis, in contracts. Finally, this activity is a sustainable strategy giving effect to sustainable building, and can be used as a criterion to implement this concept in green building rating tools.

In relation to Objective Two, some good practice has been identified, within this chapter, particularly in Canada. New buildings have been constructed with recovered products in this country, and the salvaging of heritage elements is promoted by some local authorities, offering possibilities for their reuse. The CIB, an international building research organisation, has also studied the framework associated with deconstruction and the efficient use of building products.
Chapter Two: Literature Review

The reuse of products is often not treated as a singular topic but is embedded with notions such as deconstruction, design for deconstruction, solid waste minimisation strategies and is also a strategy to achieve sustainable building. This research seeks to understand the reuse of building products on its own, even if some side interests greatly influence it. The next chapter introduces the research design adopted for this study.
3. Research Design

The literature review detailed the theories associated with the impacts of reusing products in the building industry. The key themes identified during the literature review inspired the research design, and more particularly helped in the selection of key informants. These themes were also used with the data provided from the context chapter to form the interview questions and to collect relevant data during the fieldtrip. The literature review was also essential to interpret and analyse the data collected. This chapter introduces and justifies the chosen methodology for this research, and explains how each of the research objective presented in Chapter One is addressed.

The research approach implemented for this study is both explanatory and analytical. This study seeks to understand the factors influencing, positively or negatively, the reuse of products in the Dunedin building industry. The study also seeks to analyse the successful elements which could be applied in Dunedin to encourage such activity. As a result, the aim and objectives of this research, and the literature review have helped shape the research design.

Section 3.1 refers to the strategy adopted for this study. Section 3.2 details the research process to gather and analyse information. Section 3.3 presents the ethical considerations adopted for this research. Section 3.4 discusses the strengths and limitations of this research approach and section 3.5 concludes this chapter.

3.1. The Research Strategy

3.1.1. A Qualitative Research Strategy

Research strategies are usually chosen to fit within the scope and the aim of the study. Many methods are available to conduct research in human geography, such as text analysis, questionnaires, surveys, interviews, focus groups, and participant observations. Winchester acknowledges that “in recent human geography there are coexistent, contradictory and competing communities of scholars adhering to different views of the world, different schools of thought and different approaches to research questions” (2000, p. 16). However, methods are usually selected to respond to the specific aims and research questions.
This research intends to evaluate the feasibility to reuse building products and identify the factors influencing the reuse of products in the New Zealand building industry and to offer recommendations to support this practice. Thus, the majority of the data collected had to be qualitative data. Complementary quantitative information was collected on an exceptional basis to get an indication of the quantity and cost of salvaged products.

Qualitative methods seek to achieve a general understanding of the situation and of its context. A logical but nevertheless relevant point is that qualitative methods are used to collect qualitative data (Winchester, 2000). This author highlights the utility of qualitative methods by explaining that they “attempt to gather, verify, interpret and understand the general principles and structures” (Winchester, 2000, p. 20). Bradshaw and Stratford (2000) believe that intensive methods are used to identify stakeholders, their roles and the reasons for the changes in their environment and in their behaviour. The theories developed by Winchester (2000), Bradshaw, and Stratford (2000) illustrate the aim of this study, within the context of reusing products in the New Zealand building industry. The rationale of the chosen qualitative strategy for this research lies in the fact that many stakeholders, with different viewpoints are associated with this practice, including representatives across local government, central government, building and waste sectors, and within the Dunedin community.

3.1.2. A Case Study Approach

Definition
A case study was applied in Dunedin. This paragraph details the characteristics of a case study and explains how this research responds to them. Yin considers two sets of characteristics to define a case study. The first one is related to the function of the case study:

A case study is an empirical enquiry that
  o Investigates a contemporary phenomenon in depth and within its real-life context, especially when
  o The boundaries between phenomenon and context are not clearly evident (Yin, 2009, p. 18).

According to this definition, a case study is appropriate for this research given that reusing building products is a contemporary phenomenon and an activity that is not easily
distinguishable from its context. For example, the supply of salvaged products influences the opportunities for their future reuse, while their reuse increases the demand for more products to be salvaged.

The second part of the definition by Yin refers to the case study as a process:

The case study inquiry
- Copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result
- Relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result
- Benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin, 2009, p. 18).

This research aligns with the first point of this quotation given that 17 key informants from different backgrounds discussed the reuse of building products. For the second point of this quotation, the comparison of the data from a multiplicity of sources, both literature and interviews, guaranteed the validity of the data gathered in this study. Thirdly, this research is embedded in an existing body of literature relevant to the topic, which helped refine the research questions and the research approach.

**A Case Study Approach Applied to Dunedin**

A case study was undertaken in Dunedin, New Zealand. Dunedin has many assets for this study. Four arguments support the choice of Dunedin as a location to study the reuse of building products, as detailed in the next sections: the introduction of an earthquake-prone buildings policy, the reuse of products in heritage buildings, some education departments favourable to sustainable building, and a gap in the literature on the reuse of building products in New Zealand low-growth cities.

**The Introduction of an Earthquake-Prone Buildings Policy**

From a national perspective, the earthquakes in Christchurch in 2010 and 2011 have motivated the revision of the *Dangerous, Insanitary and Earthquake-Prone Buildings Policy* within the DCC, which is currently at a draft stage. This document advocates a further strengthening of buildings, potentially resulting in more buildings or parts of buildings to be demolished if this policy is adopted (Dunedin City Council, 2011a). The necessity for earthquake-prone buildings to comply with harsher insurance clauses is also a reality that owners have been facing recently in Dunedin (Key Informant 5). These recent
burdens have accentuated the cost of keeping these buildings up to standard and therefore compromise their viability from the developer’s perspective (Key Informants 5; 10). The adoption of this draft policy has the potential to generate the demolition of existing buildings and heritage buildings, releasing reusable building products. There is therefore a need to anticipate their reuse if this draft policy is adopted.

**The Reuse of Products in Heritage Buildings**

Dunedin values and encourages the preservation of its heritage buildings, which are at risk. Due to its rich past, lots of buildings were built in Dunedin following the gold rush in the early 1860s (Clark, 1962). The oldest existing building, Costorphine House, was erected in 1863 (New Zealand Historic Places Trust, 2011a). Some of these buildings are now in a poor state because they are currently under-used and consequently under-maintained; they might be subject to demolition or deconstruction in the future (Key Informant 5). Consequently, it is likely that large volumes of products, even heritage products such as stone and timber become available for a future reuse. Parts of these products may be determined to be of good quality, and reusing them is logical to preserve the remaining heritage buildings and the present townscape.

The DCC is known for encouraging the adaptive reuse of heritage buildings on its territory (Dunedin City Council, 2007). It is aware of the value of its heritage buildings, especially their contribution to its townscape and as an economic asset (Dunedin City Council, 2006, 2007). The current strategy consists of the adaptive reuse of heritage buildings; an annual competition has been set up by the DCC to reward the best reuse of heritage buildings (Dunedin City Council, 2011b). However, little is known on the position of the DCC regarding the recovery and the reuse of building products in general, and more specifically for heritage buildings.

**Education Departments Favourable to Sustainable Building**

Dunedin has some education departments favourable to sustainable building, possibly encouraging the reuse of building products locally. The University of Otago is committed by commissioning sustainable buildings when it has to construct new buildings on its campuses (University of Otago, n.d.-a). Besides, some of its departments, such as the law and the design departments are involved in researching more sustainability in buildings (University of Otago, n.d.-b; Warnock, 2007). The Otago Polytechnic is active in the
Sustainable Habitat Challenge, with the University of Otago. This programme notably encourages an efficient use of building products, including their reuse (Sustainable Habitat Challenge, 2008). One of the lead co-ordinators of this programme works at Otago Polytechnic and many students participate in this project (Birnie, et al., n.d.; Otago Polytechnic, n.d.-b). Educational organisations promoting sustainable building and an efficient use of building products may indirectly impact positively on the reuse of building products in Dunedin as a strategy to implement sustainable building.

A Gap in the Literature on the Reuse of Building Products in New Zealand Low-Growth Cities

Previous research in New Zealand has focussed on densely populated areas with significant growth (Storey, 2002; Storey, et al., 2003, 2005; Storey and Keane, 2008). The case study of Dunedin presents an alternative view to research from Victoria University by analysing the situation in an area with a limited growth, although being sufficiently populated. Indeed, Dunedin’s population ranks eighth in size out of the 73 districts in New Zealand, with about 120,000 inhabitants, suggesting that there is sufficient building activity in the territory and a potential for reusing building products (Statistics New Zealand, 2006).

3.1.3. The Choice of Key Respondents

The choice of key respondents for this study reflected the involvement of stakeholders described in the literature. Besides, additional key respondents were selected to echo the local context. The table provided in Appendix C lists the professionals who were interviewed for this research. The number of interviewees reflects the number of stakeholders involved, or likely to be involved, in the process of reusing products in buildings. People from both national and local agencies were interviewed to provide an overall picture and an understanding of the processes and factors currently influencing the reuse of products in the building industry, both in Dunedin and New Zealand.

The building community was extensively consulted to get an overview of their involvement with reusing building products. Two architects/designers, one with a traditional perspective, the other with an environmental view were selected to analyse the role of designers as promoters of the reuse of products in building projects, as stated in the literature (Public Architecture, 2010). A builder and a representative of the building community were chosen to discuss the issues they face when they use salvaged building
products. Two Dunedin developers and heritage building owners were approached to understand their perceptions on this activity. A Dunedin building consent officer and an advisor on building standards were contacted to get an insight of the possibilities offered by the legislation to reuse building products. An educational from the national organisation in charge of educating builders and an education manager were contacted to know if sustainable building principles, including the reuse of building products were taught to the building community.

Regarding waste management and the salvaging of building products, a DCC waste manager, a local demolition/deconstruction professional and salvager, and a sustainability adviser were consulted to get an understanding of the influence of C&D waste policies on building products’ recovery and reuse.

Given the significance of the recovery of heritage building products in the literature (Gorgolewski, 2008) and the significance of heritage buildings in the local context, three planners with different backgrounds were interviewed; one was a town planner, the second one was a heritage planner from the DCC and the third was from the New Zealand Historic Places Trust (NZHPT).

3.2. The Research Process
The research process was designed to prepare and organise the research. It ensures the researcher pursued a logical process to collect, analyse and interpret data.

3.2.1. Collection of Secondary Data
Data was collected from literature, including journal articles, web sites and books. The key themes identified were: the reuse of building products, solid waste management, deconstruction, design for reuse and other similar design, designing with salvaged products, stakeholders and their lack of support for reusing building products, the economic influence of reusing products, statutory framework, and suitable building.

3.2.2. Definition of the Research Objectives
The research objectives were prepared in accordance with the research issue, aim and objectives. They are a reflection of the existing literature and were designed to narrow down the topic and emphasise the core of this research.
3.2.3. Collection of Primary Data

The interviews with key informants were conducted in July and August 2011. They usually lasted between ten minutes to ninety minutes. An interview schedule was programmed for each interviewee to ensure that the questions were relevant and appropriate to their background.

Data was collected through semi-structured interviews; predetermined questions were asked of the key informants and were adapted to fit the answers provided. The questions were usually asked in a certain order as they became more complex to answer as the interviews progressed. Meanwhile, the researcher remained flexible and asked more in-depth questions when a theme developed by a key informant had not been identified beforehand. A system of open questions was used to allow the interviewees to expand on the points that they considered being relevant and salient. All the interviewees agreed to the principle of being audio-recorded. Finally, the interviews were converted into a text, through the reconstruction from a transcription of an audio-tape (Minichiello, et al., 1990, p. 254).

3.2.4. Precautions to Avoid Bias and Misinformation

The research topic is often related to the background of the researcher (Clough and Nutbrown, 2007). Although the literature review provided some theory, the interpretation of the information can be biased with the introduction of personal opinions into the research (Dowling, 2000; Marshall and Rossman, 1989). Misinterpretation can also arise. Another bias is intersubjectivity: the information can be interpreted within the world perceived by the researcher after reading and interacting with people (Dowling, 2000). Another identified bias can result in the formulation of the set of questions used during the interviews. Lapadat and Lindsay also warn that the transcription is usually subjective and realised in such a way that it confirms the theory defended (1999).

This subjectivity and the misinterpretation of data can result in information diverted from its original meaning. Critical reflexivity as advised by Dowling (2000) was the method used to counter-analyse the data. The researcher tried to remain as neutral as possible during the whole research process. As soon as any misunderstanding that could confuse the researcher as the discussion developed by any key informant, clarifications were requested.
Before completing the interview, the researcher checked the veracity of the information collected during the interviews by reformulating the points developed and soliciting a confirmation of the statements. In addition, some of the key informants have shared personal opinions during the interview process. These views are not attributed to anyone in Chapter Five and Chapter Six to avoid confusion between the philosophy of the organisation they work for and their personal perceptions and views.

Scott defines four criteria to assess the quality of the data collected:

1. **Authenticity.** Is the evidence genuine and of questionable origin?
2. **Credibility.** Is the evidence free from error and distortion?
3. **Representativeness.** Is the evidence typical of its kind, and, if not, is the extent of its untypicality known?
4. **Meaning.** Is the evidence clear and comprehensible? (1990, p. 6).

These criteria were applied during the data collection. Secondary data was gathered as much as possible from formal academic literature to ensure its ‘authenticity’: peer-reviewed journal articles, published books. Reliable government documents and websites from public organisations were also consulted. In addition, some articles from international conferences, though not always peer-reviewed, were analysed given the difficulty to collect published and validated academic papers on deconstruction and reuse of products. Primary data was collected with key informants having an interest or expertise in the building or waste industry. Although it is not always possible to distinguish errors, the ‘credibility’ of the information collected was constantly assessed with common sense and compared with other sources if uncertainties arose.

The triangulation of sources was a method used to check the validity of the information collected once the collection phase of the research was completed. Marshall and Rossman define the triangulation as “the act of bringing more than one source of data to bear on a single point” (1989, p. 146). The use of multiple sources (from government agencies, academics, associations and professionals), collected from different methods (literature review and interviews), allowed the comparison of the data gathered on reuse activity in Dunedin and in New Zealand, the factors influencing this activity and on the opportunities to encourage it. The representativeness and the meaning of the data collected were ascertained by extracting both the information and the context in which it was discussed.
3.2.5. Data Analysis

The five steps advised by Dowling were followed to code the data from the interview (2000). A coding system was developed to retrieve data (Dunn, 2000; Lapadat and Lindsay, 1999). Themes were created to organise and list the data collected (Marshall and Rossman, 1989). These themes were developed according to the research objectives. The transcripts were prepared following the interviews. Each theme was allocated a specific colour. Matching information was highlighted in the electronic files containing the transcription of the interviews and similar colour information was compiled in a new electronic file. Once the results were completed, they were compared with the secondary data to develop a discussion relevant to the research objectives.

3.3. Ethical Considerations

Before conducting the literature review, ethical standards and plagiarism issues were acknowledged. Later, ethical implications were thought through carefully to avoid any issue to arise during the interview process. Ethics were a preliminary step necessary to think of the consequences of the interviewing process. It is actually a contract between the researcher, the university and the interviewees. Ethics were written to predict any issue likely to occur during the research process (Dowling, 2000). They stipulated the obligations and responsibilities that the researcher has to comply with when collecting data. Ethics also made explicit the expectations that the researcher had prior to interviewing the selected participants. From a practical point of view, it was not expected that any issues arose for this research and this prediction was right.

To respect the participants, the interviewees were provided with an information sheet and a consent form that they signed to prove that they agreed to participate in the process. The information sheet, joined in Appendix D, explains the qualification of the researcher and the nature of the research, including the issues, aims and objectives of the research. In addition, the researcher offered the participants a summary of the results if they made an enquiry to thank them for their collaboration.

Dowling states that “by asking questions or participating in an activity we alter people’s day-to-day lives. And communicating the results of research can potentially change social situations” (2000, p. 24). To avoid any conflict to arise in their work or private life, the interviewees remained anonymous in this study. It was agreed that private details about
individuals would not be collected and therefore would not be released into the public domain. The researcher respected their confidentiality. The original field notes, tapes and transcripts were securely stored in a location with restricted access. According to the University’s research policy, the raw data on which the results of the research are based on are retained in a secure storage for five years, after which it is destroyed. Interviewees were also allocated a number to remain anonymous.

Although participants agreed to be interviewed and were helpful in the collection of data, the research approach has strengths and limitations which are analysed in the next section, Section 3.4.

3.4. Strengths and Limitations of the Research Approach

3.4.1. Strengths of the Research Approach

The research approach has been thought through carefully, by preparing the data collection, which has helped in the data analysis and data presentation in this thesis. The literature review, undertaken first, has revealed key thematic areas which have guided the research approach. Participants had the freedom to develop their own arguments with the semi-structured interviews, which brought flexibility in the process and resulted in new considerations to be taken into account.

The information presented to depict Dunedin reuse activity in Chapter Five was provided by local people, who have an in-depth knowledge of the situation and can analyse and criticise it accordingly. A face-to-face encounter with key informants allowed a large amount of data to be collected (Marshall and Rossman, 1989). The interview process allowed a complete analysis of social and technical issues and was pertinent to highlight complex links. The multiplicity of interviewees having a different background emphasised each stakeholder’s viewpoints, ensuring that no gap ensued after the interview process.

3.4.2. Limitations of the Research Approach

The research approach was time-restrained, providing opportunities for future research. This study would have benefited from the interview of a structural engineer, who is commissioned to write reports proving the quality of salvaged products reused for structural purposes. This did not happen because of time constraints of the key informant.
selected. A further interview with staff from the New Zealand Green Building Council (NZGBC) would have provided valuable information given that they have been quoted by Key Informant 7 and Key Informant 14 to be promoting the reuse of products in New Zealand. This interview did not occur due to time constraints.

Another limitation of this research is its wider applicability. The data collected focuses on the Dunedin local context. While some findings may be relevant in a broader sense to New Zealand overall, a generalisation of the results can be difficult and uncertain. As a consequence, embedding the results of the research as a theory in the literature may be inappropriate (Marshall and Rossman, 1989, p. 104). However, special attention was paid to the presentation of the results and of the discussion in Chapters Five, Six, and Seven. Another weakness is that the replication of this research in another context is delicate as the Dunedin local environment is unique.

3.5. Summary

This chapter outlined the research design used in this study. A case study and a qualitative strategy were adopted to reflect the aims of the study and its associated research objectives. Qualitative data was sought to discover how common this activity is and to identify the factors influencing it. Dunedin was chosen as a case study following four arguments. The research process was designed carefully to organise a logical and coherent collection of data. The gathering of data was achieved by selecting relevant concepts in the literature and after the preparation of specific questions for participants. The triangulation of the sources consulted and of the methods applied during this study enabled a comparison between the different sources of information, to check their validity and expose the findings within the existing literature. Accordingly, special attention was given to ethical considerations to respect the values and privacy of the interviewees. Although the research presents some strength, limits are acknowledged, giving opportunity for future research. The context in New Zealand and particularly of Dunedin is developed in the next chapter.
4. New Zealand and Dunedin Context

Chapter Four examines the New Zealand and Dunedin context in which the research takes place. It provides an overview of the industries likely to be involved with the reuse of building products and investigates the role played by the legislation and the likely stakeholders in the promotion of this activity. Two research objectives are addressed in this chapter: Objective One ‘to investigate to what extent the building industry in New Zealand currently reuses products’, and Objective Two ‘to identify the barriers against and the opportunities for the effective reuse of products in the Dunedin building industry’.

Section 4.1 is dedicated to the context in New Zealand whereas section 4.2 is specific to Dunedin. In both these sections, a profile is set for the building industry, for C&D waste production, and for the demolition industry. The legislation relevant to the reuse of building products is then presented, followed by an examination of the role of the stakeholders involved or likely to be involved in this activity. Finally, section 4.3 provides a summary of this chapter.

4.1. New Zealand

4.1.1. Overview

New Zealand is a 268,680 km² country, composed of two main islands, and with a population of approximately 4.4 million inhabitants (Statistics New Zealand, 2011d). It is located in the South-West Pacific Ocean and is remote from the rest of the world. According to the Local Government Act 2002, the country is administratively divided into 11 regional councils and into 67 territorial authorities, either district councils or city councils.

New Zealand is a relatively new country. Europeans began settling in the early 1800s following Māori settlement periods. The oldest houses date from the middle of the nineteenth century and are in a relatively good state. Buildings are usually ‘light timber frame’ (Storey, et al., 2005, p. 187).
New Zealand suffers from expensive overseas products due to its remote location and the consequent expensive import of materials. In the past, imports mainly from England, were long and expensive (Pollock and Labrum, 2010). Today, New Zealand is still put at a disadvantage due to its location and its small population. The Department of Building and Housing has stated recently that “New Zealand is a small market, which makes negotiating good prices more difficult. In the face of increased demand from Asia and major post-disaster rebuilds in Japan and Australia, building materials prices will likely continue to rise over time” (Department of Building and Housing, 2011, p. 20). These statements imply that a priori local materials, including salvaged building products, can have an economical incentive over new and foreign building materials.

4.1.2. New Zealand Profile of the Reuse of Building Products and of the Key Concepts Embedding It

Overview of the Reuse of Building Products

Limited Information Available
The reuse of building products is a topic that has not been extensively studied in New Zealand. The written information available on the New Zealand building products recovery and reuse comes from Victoria University. However, their research is often geographically limited to the North Island, to cities such as Auckland or Wellington.

Storey is particularly active in this topic. He has written many articles on the efficient use of building products and their reuse. He is the New Zealand reporter to the international working commission W115 of the CIB and he has become one of the co-ordinators of this group (Chini, Schultmann, and Storey, 2011).

A Multitude of Barriers
According to Storey and Keane, “there is currently no national strategy to utilise construction materials in an effective or responsible manner” (2008, p.41). The authors have found that reusing building products usually happens for repairing dwellings, and particularly to keep their singular character. They refer to the expression ‘cherry picked’ materials to illustrate how uncommon building products reuse is (Storey and Keane, 2008, p. 46).
Many barriers to reusing building products have been identified in the papers published by staff from Victoria University. They are listed, according to their nature, in the following table, Table 4.1.

Table 4.1 – Barriers to the Reuse of Building Products in New Zealand

<table>
<thead>
<tr>
<th>Barriers to the Reuse of Building Products</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
</tr>
<tr>
<td>The lack of national strategy to use building products in an effective manner / The absence of a unified initiative to materials stewardship and reuse of building products</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>The lack of support from the government for the reuse of building products, notably green government procurement</td>
<td>Storey and Pedersen, 2003</td>
</tr>
<tr>
<td>Social</td>
<td></td>
</tr>
<tr>
<td>The lack of adhesion of the industry and local authorities to waste minimisation</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>The designers’ preference to use new materials</td>
<td>Storey and Pedersen, 2003</td>
</tr>
<tr>
<td>The reluctance of contractors to reuse products</td>
<td>Storey, 2002</td>
</tr>
<tr>
<td>The lack of communication between the building and demolition/deconstruction industries</td>
<td>Storey, et al., 2005</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>The lack of education of New Zealand society who has a negative perception of second-hand or salvaged products</td>
<td>Storey and Pedersen, 2003</td>
</tr>
<tr>
<td>Insufficient information on closed materials loop and deconstruction</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>Legislation</td>
<td></td>
</tr>
<tr>
<td>The lack of certification for salvaged products</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>The liability attached with the use of salvaged products</td>
<td>Storey and Pedersen, 2003</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
</tr>
<tr>
<td>The uneconomic aspect of reusing some building products: low cost of some new building products, which are sometimes subsidised and the undissuading cost of landfilling C&amp;D waste</td>
<td>Storey, et al., 2005</td>
</tr>
<tr>
<td>Waste</td>
<td></td>
</tr>
<tr>
<td>Uncertainties on the statistics on C&amp;D waste due to the lack of a consistent monitoring for C&amp;D waste, depending on territorial authorities</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>The absence of a baseline to assess the progress in waste minimisation</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>C&amp;D waste if considered as an issue is only considered as a landfill issue, not a resource issue</td>
<td>Storey and Keane, 2008</td>
</tr>
<tr>
<td>Technical</td>
<td></td>
</tr>
<tr>
<td>The out-dated character of some building products (safety glass instead of unsafe one for example)</td>
<td>Storey, et al., 2005</td>
</tr>
<tr>
<td>The wrong use of connections between building products for design for reuse</td>
<td>Storey, et al., 2005</td>
</tr>
<tr>
<td>The lack of adoption of design for reuse</td>
<td>Storey, et al., 2005</td>
</tr>
<tr>
<td>More considerations necessary in New Zealand for design as it is a seismic country</td>
<td>Storey, et al., 2005</td>
</tr>
</tbody>
</table>
According to this table, there are multiple barriers to the reuse of building products cited in academic articles, involving social, education, legislation, economic and waste hindrances.

**Overview of the Building Industry**

**Statistics**

**Significance of the Construction Industry**
The construction industry is significant in New Zealand. In 2008, it was the third largest industry in New Zealand with 50,665 businesses behind the property and business services, and agriculture, forestry and fishing industries (Statistics New Zealand, 2009). It accounted for 10.8 percent of all companies in New Zealand, and provided work for 6.6 percent of the total employees, being the sixth largest employer (Statistics New Zealand, 2009).

**An Inconsistent Activity**
The global financial crisis has impacted on this sector and these figures are subject to changes. The total number of building consents issued has decreased since 2007; the value of these buildings has also lessened (Statistics New Zealand, 2011a). A total of 50,302 building consents have been issued from August 2010 to August 2011, against 77,675 for the period August 2006/August 2007 (Statistics New Zealand, 2011b). Information provided by the Department of Building and Housing (2011) confirms this situation: the number of residential and non-residential building consent applications for the first trimester 2011 has been at its lowest since recording began. However this organisation is expecting an economic recovery in the future following the recent Christchurch earthquakes.

**Sustainable Building**
Jenkin and Pedersen Zari (2009) estimate that the concept of sustainable building has been considered in New Zealand since 2005. Many organisations advise on sustainable building, such as the Energy Efficiency and Conservation Authority, the Building Research Association of New Zealand (BRANZ), Consumer, Sustainable Habitat Challenge, and the NZGBC.

Efforts on sustainable building are based on energy consumption and particularly on improving the existing dwellings. The Energy Efficiency and Conservation Authority educates New Zealanders on good practice in regard to this issue through the design of
programmes such as *Warm Up New Zealand: Heat Smart and ENERGYWISE™ homes*. Themes discussed vary: insulation, dampness in the house, hot water cylinder consumption, and energy consumption of appliances (Energy Efficiency and Conservation Authority, 2012). A consortium of organisations have also collaborated to develop the Smarter Homes programme, a guide for more sustainable buildings, developed for the public, and emphasising ways to reduce their energy consumption (Department of Building and Housing and Consumer, 2008). This programme is further detailed in section 4.1.4.

**Summary Building Industry:** Despite the financial crisis, the building industry still occupies a significant place in the New Zealand economy. Setting up more sustainable practices in this industry can result in a great minimisation of environmental impacts in the country given its national significance. In New Zealand, many organisations understand this challenge and promote sustainable building. The national principles of this concept focus on energy efficiency, similar to what is occurring worldwide.

**Overview of C&D Waste Production**

**Overview of the C&D Waste Industry**

According to the survey carried out by the consultancy Sinclair Knight Merz for the Ministry for the Environment (2010), waste disposal sites comprise cleanfills, municipal solid waste landfills, and non-municipal solid waste landfills. According to the Sinclair Knight Merz’s investigation, there were 214 disposal sites in New Zealand in 2008. Cleanfills are disposal sites receiving inert materials whereas municipal solid waste landfills receive municipal solid waste and C&D waste (Beca Carter Hollings and Ferner Ltd, 2002).

C&D waste are sent to various locations. Depending on their nature, non-hazardous C&D waste are disposed either in cleanfills or municipal landfills whereas hazardous C&D waste are disposed in special sites when they exist. In the absence of such sites, this waste is buried in municipal landfills (Sinclair Knight Merz, 2010). In 2005, Storey, *et al.* considered that most of C&D waste were sent to cleanfills (2005).
**Chapter Four**

*The Monitoring of C&D Waste*

Waste issued from the construction and demolition industries were accounted for in the past but are not recorded anymore in New Zealand. The Ministry for the Environment developed a method to collect data on waste production in 1992: the waste analysis protocol, superseded by the solid waste analysis protocol in 2002. C&D waste is not considered as a category anymore, as presented in Table 4.2:

Table 4.2 - Categories of Waste Recorded in New Zealand (from Ministry for the Environment, 2009, p. 4)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>Ferrous metal</td>
<td>Metal products predominately made from steel</td>
</tr>
<tr>
<td></td>
<td>Non-ferrous metal</td>
<td>Other metal, such as aluminium, copper, lead</td>
</tr>
<tr>
<td>Construction and Demolition</td>
<td>Rubble</td>
<td>Concrete, rocks, plasterboard and ceramics</td>
</tr>
<tr>
<td></td>
<td>Timber</td>
<td>Timber lengths, furniture, sawdust</td>
</tr>
</tbody>
</table>

The researcher understands that it is currently impossible to determine the amount of waste issued from the construction and demolition industries following these categories changes. According to this table, a landfilled corrugated iron roof is not considered as a C&D waste but as a metal waste. Furthermore, the waste from a sawmill which is mainly sawdust is included in the timber waste category. This makes the set ‘rubble + timber’ waste non-specific to construction and demolition.

The categories of waste defined in the solid waste analysis protocol do not allow the obtaining of reliable statistics on waste issued from the C&D waste industries. This has the potential to hide the significance of these producers’ impacts on the total waste production. This situation can result in a lack of actions proposed and undertaken towards the building community to decrease their waste production and therefore does not support the reuse of building products.
**Incomplete Data on C&D Waste**

Despite progress on the monitoring of C&D waste, there are still some difficulties to obtain reliable statistics on this waste stream. Following the adoption of the Waste Minimisation Act 2008, a new method has been developed in New Zealand to report on solid waste production and their diversion from landfills. Only solid waste received in disposal facilities, as defined in section 7 of the Act, is monitored. As a report from the Ministry for the Environment concedes, “it is not possible to obtain any accurate information or a reliable estimation of the amount of waste sent to cleanfills or managed fills” (Ministry for the Environment, 2011c, p. 16). Although the amount of waste produced is unknown, statistics of waste disposal to municipal landfills are now supposed to be more accurate (Ministry for the Environment, 2011e, p. 1). Following the adoption of a new method to generate waste statistics, comparisons with previous data is meaningless.

**Overview of C&D Waste Production**

According to the Ministry for the Environment, New Zealand landfilled 2.531 million tonnes of waste in disposal sites in 2010. This statistic only refers to the amount landfilled in disposal sites as defined in the Waste Minimisation Act 2008. It means that the amount of solid waste received by cleanfills and industrial landfills is excluded from the scope of official statistics (Ministry for the Environment, 2011e).

Details on the composition of the waste streams for 2010 are not currently available. Therefore, Figure 4.1 is provided to give the reader an overview of the latest waste composition available in New Zealand, although data is now out-dated. This information is the result of an assessment carried out by the Ministry for the Environment of the waste landfilled in four indicator sites in New Zealand (Silverstream, Kaikoura and Green Island Landfills and Matamata transfer station) for the period 2007-2008. Following the nature of the assessment, information is provided in percentages as information in tonnages would be meaningless, from a national perspective.
According to Figure 4.1, rubble and timber account respectively for 16 and 11% of the total waste landfilled in the national indicators sites. This means that, theoretically, according to the definitions provided by the Ministry for the Environment, C&D waste represents 27% of the total waste produced. Complementary information, contradicting this figure, is provided on the C&D waste webpage of the Ministry for the Environment (2010a), stating that this waste stream accounts for up to 50% of the amount of waste generated, with approximately 20% being sent to landfills and 80% sent to cleanfills.

**An Awareness of the Insufficient Diversion of C&D Waste**

In New Zealand, the diversion of waste from landfills is unsatisfactory, although some efforts are made to reduce C&D waste production. The latest information on waste production released by the Ministry for the Environment states that most of the waste (‘approximately three quarters’) received in municipal landfills could be diverted (Ministry for the Environment, 2011e, p. 2). However, awareness of the building industry on their waste production is growing. According to Storey and Keane (2008), the biggest New Zealand building company, Fletchers, is reducing the amount of C&D waste produced during the construction phase of buildings. These authors believe that this is progressively influencing other building companies to adopt this strategy. The same source indicates that the demolition industry is paying more attention to the value of salvaged building products.
Summary C&D waste production: C&D waste amounts for a significant part of the national total waste produced and landfilled, although accurate figures are not available. Indeed, waste statistics accountancy methods have evolved a lot within the last 20 years and do not consider all the sites where C&D waste are disposed of in New Zealand. Despite progress in monitoring waste, waste diversion is not maximised. Therefore, there is a need to develop strategies to decrease the amount of waste landfilled.

Overview of the Demolition Industry

Insufficient Information on the Demolition Industry
Obtaining statistics on the demolition industry in New Zealand is difficult. The demolition industry is unregulated in New Zealand, meaning that anyone can proclaim being a demolition worker (Key Informant 17). In addition, the number of demolition consents issued is not publicly released by Statistics New Zealand. However, following the Christchurch earthquakes in 2010 and 2011, it can be supposed that this activity has increased in New Zealand, and more specifically in the Canterbury region (Canterbury Earthquake Recovery Authority, 2011).

Deconstruction
Deconstruction is increasingly being considered by the demolition industry. Some major demolition companies in the North Island are now specialised in deconstructing, reaching up to 95% resource recovery, though no information is available on the industry in the South Island (Storey and Keane, 2008). According to the same source, Nikau and Ward, two companies from the North Island, have developed equipments facilitating the deconstruction process. Despite the adoption of more sustainability in the demolition, Storey, et al. predict that in the future, the recovery of products from new houses will become more difficult as the materials used nowadays are not as durable and valuable as those used in the past (Storey, et al., 2005).

Summary of the demolition industry: Insufficient information is available on the demolition industry in New Zealand. However, it seems that it is progressively being engaged in resource recovery.
4.1.3. Relevant Legislation

In New Zealand, and consequently in Dunedin, four acts are related, directly and indirectly, to the reuse of products in buildings. The Building Act 2004, the Resource Management Act 1991, the Historic Places Act 1993, and the Waste Minimisation Act 2008 are examined in the following sections.

Building Legislation

The Building Act 2004 and the Building Code are under the authority of the Ministry of Building and Construction and the Department of Building and Housing is the executive authority. The Building Consent Authorities, which are mainly territorial authorities, are in charge of enforcing this legislation. The Building Act and its Code deal with building work and regulate the industry with a performance-based approach to ensure people’s safety (section 3 of the Act). An analysis of the building legislation, is provided in the light of the reuse of building products in the next sections.

The Building Act 2004

The purpose of the Building Act, presented in section 3, is to:

Provide for the regulation of building work, the establishment of a licensing regime for building practitioners, and the setting of performance standards for buildings, to ensure that—

(a) people who use buildings can do so safely and without endangering their health; and

(b) buildings have attributes that contribute appropriately to the health, physical independence, and well-being of the people who use them; and

(c) people who use a building can escape from the building if it is on fire; and

(d) buildings are designed, constructed, and able to be used in ways that promote sustainable development.

Although the Building Act has a reference on sustainable development, it does not necessarily require it. Subsection 3(d) of the Building Act refers to sustainable development, but its wording is loose: “buildings are designed, constructed and able to be used in ways that promote sustainable development” (my emphasis). Interpretation of this section is that the expression ‘able to be used’ instead of ‘are used’ in subsection 3(d) of the Building Act reflects the fact that using a building in a way that promotes sustainable development is optional and consequently not mandatory. In this same subsection, the word ‘promote’ has no legal consequence and has a weaker meaning than, for instance, the
verb ‘guarantee’. Therefore, sustainable development in the building activity does not seem to be a requirement, but a factor to consider. According to a lawyer, there are very few articles on the New Zealand Building Act 2004 and there are not any cases interpreting the meaning of the Building Act. This lack of legal framework results in the lack of reference to support this assertion.

Additionally, 16 principles are defined in section 4 of the Building Act to guide decision-makers. It appears that many of them are related to sustainability, suggesting the importance of this paradigm in the decision-making process. A selection of these principles is presented and discussed below following their relevance to this study:

(2) In achieving the purpose of this Act, a person to whom this section applies must take into account the following principles that are relevant to the performance of functions or duties imposed, or the exercise of powers conferred, on that person by this Act:

(c) the importance of ensuring that each building is durable for its intended use:

(e) the costs of a building (including maintenance) over the whole of its life:

(n) the need to facilitate the efficient and sustainable use in buildings of—

(i) materials (including materials that promote or support human health); and

(ii) material conservation:

(p) the need to facilitate the reduction in the generation of waste during the construction process.

The principles detailed above introduce sustainable criteria in the building legislation. The researcher understands that reusing building products complies with all these selected principles. Subsections 4(2)(c) and (e) refer to the life cycle of the building, with durability and financial considerations. Subsections 4(2)(n)(i) and (ii) refer to the use of materials and material conservation, indirectly referring to the life cycle of either the building or the materials forming it. Finally, subsection 4(2)(p) has a limited impact on C&D waste production as it only recommends waste minimisation during the construction process.

The Building Code
According to section 16 of the Building Act 2004, “the building code prescribes functional requirements for buildings and the performance criteria with which buildings must comply in their intended use”. Therefore the Building Code influences the content of building consent applications. Many key informants refer to clauses B1 and B2 of the Building
Code (respectively entitled ‘Structure’ and ‘Durability’) to affect the use of salvaged building products in the structure of buildings (Key Informants 2; 4; 9; 12; 13; 14).

Shortly explained, Clause B1 defines a minimal performance of materials and products to guarantee the safety of people occupying a building and their investment, whereas Clause B2 requires some proof guaranteeing the lifespan of a building. These clauses are displayed in Appendix E. It is also found that reusing building products can occur for architectural purposes as there is no clause in the Building Code specific to the products used to decorate a building.

More anecdotic, the building legislation makes some references to the demolition of buildings, and particularly to the safety associated with the demolition of buildings (section F5 of the Building Code). However, no recommendation to deconstruct instead of demolish are made in the building legislation (Key Informant 17).

Acceptable Solutions, Verification Methods, and Alternative Solutions
Building consent applications must demonstrate that the building project complies with the legislation. For this, the plans must refer to acceptable solutions, verification methods or alternative solutions. These methods are examined in the following sections.

Acceptable Solutions and Verification Methods
The Department of Building and Housing has developed some streamlined solutions, analysed in the next paragraph, to demonstrate that a proposed building work complies with the legislation. However, none of them refers to the reuse of building products. Consequently, anyone wanting to use salvaged products in the structure of their building has to demonstrate their properties as they are alternative solutions, a hindrance for this activity.

Acceptable solutions and verification methods are a type of regulation mentioned in the Building Act 2004, in section 20 ‘Regulations may specify that there is only 1 means of complying with building code’ and in section 401 ‘Regulations: acceptable solutions, verifications, etc, that must be complied with in order to comply with building code’. Acceptable solutions are detailed in approved documents whereas verification methods are used to demonstrate that an alternative solution complies with the Building Code (Department of Building and Housing, 2006). Key Informant 14 explains that acceptable
solutions and verification methods detail the process that building professionals have to follow to ensure the building’s performances in agreement with the legislation. This informant acknowledges that acceptable solutions and verifications are similar, in the sense that if they are used in a building consent application, the building consent authority has to accept them.

Alternative Solutions

Alternative solutions are practices that are not considered by the authorities. According to this interviewee, the advantage with alternative solutions is that they give room for innovation and give a new role for the building consent authority:

An alternative solution could be anything that someone dreams up provided that the councils are willing to accept it. Councils themselves have to look at these alternative solutions and say: “Do we actually think that this is a good design? Is it going to deliver something that performs and works?” So within the alternative solutions, the councils have to make that call (Key Informant 14).

Key Informant 4 and 14 explain that when a design involves an alternative solution, the architect has to demonstrate that the building’s performances meet the criteria set in the Building Code. Key Informant 14 reports that many options are available to do so: in-service history, expert opinion, and testing; but also emphasises the difficulties faced with alternative solutions, especially with overseas materials:

The main problem with any sort of alternative solution is try to show equivalence with the Building Code or the acceptable solution: “this is going to achieve the same level of performance”. That’s often [the case] particularly [with] overseas products. It’s hard because often tests will be set up a little differently: the testing or the appraisals look at slightly different aspects. So, trying to cover all the things you need to do for the New Zealand Building Code; that’s probably the difficulty, it’s just trying to cover all these aspects (Key Informant 14).

As Key Informants 2, 4, 5, and 14 emphasise, reusing building products is an alternative solution and demonstrating the performances of the building can deter some people to do it. Key Informant 14 mentions the use of salvaged tainted windows following the alteration of a building; people might want to reuse these windows but are not encourage to proceed with it because the properties of these windows do not meet the legislative requirements.

The next section introduces a concept widely accepted by the building industry although it is not a legal principle.
Chapter Four

The ‘Like for like’ Principle
Although the term ‘like for like’ is not defined legally, it refers to reparation or maintenance without necessitating any building consent in advance (Pringle, 2008; Key Informants 3; 14). Building professionals understand it as a principle allowing for replacement of a deteriorated product with a similar one, without having to apply for a resource or a building consent. They can also substitute it with another product which does not comply with the latest version of building legislation (Key Informant 4; Pringle, 2008). In theory, this principle allows repair of buildings with salvaged or recovered products. Key Informant 4 gives as an example the replacement of a broken single-glazed window with another single-glazed window, even if it does not comply with the Building Act and the Building Code.

However, there are limitations to the systematic replacement of a defective product with a similar one without building consent. This results in a murky like for like principle. According to Pringle’s analysis of the newsletter Codewords 17 from the Department of Building and Housing (2008), a replacement ‘like for like’ is not allowed for all building products and a building consent might be necessary in some circumstances. The author cites as an example the need for a building consent to replace a pile foundation if uncertainties remain on its carrying load. Although some examples are given by the Department of Building and Housing, there is no exhaustive list of building products illustrating the scope of this principle for the building industry.

Summary Building Legislation: Although the Building Act 2004 presents some sustainable principles, the building legislation is usually a barrier to the reuse of building products in the structure of a building. The high performances required in the building consent application mean that when planning to carry out this activity, alternative solutions are used to demonstrate the soundness of the building. However, when salvaged products are to be reused for renovation or maintenance, a consent is not always mandatory initially.

Planning Legislation
Planning legislation embraces the Local Government Act 2002, the Resource Management Act, 1991, and the Heritage Building Legislation. These documents are analysed in the following sections.
The Local Government Act 2002
The purpose of the Local Government Act is to “provide for democratic and effective local government that recognises the diversity of New Zealand communities” (section 3). It offers mechanisms for local authorities to be active and encourage a sustainable development (section 3). Some mechanisms under the Local Government Act, such as the long-term council community plans and the bylaw-making power for territorial authorities can be encouraging for the reuse of building products.

Long-term Council Community Plan
Following section 93 of the Local Government Act, local authorities, both regional councils and territorial authorities, must have a long-term council community plan for a 10 year financial period. A particular consultative process, detailed in section 84 must be followed prior to adopting this plan. According to section 93(6), the purpose of a long-term plan is to:

(a) describe the activities of the local authority; and
(b) describe the community outcomes of the local authority’s district or region; and
(c) provide integrated decision-making and co-ordination of the resources of the local authority; and
(d) provide a long-term focus for the decisions and activities of the local authority; and
(e) provide a basis for accountability of the local authority to the community; and
(f) provide an opportunity for participation by the public in decision-making processes on activities to be undertaken by the local authority.

Borrie and Memon state that long-term council community plans allow local authorities to establish a ‘medium-term policy framework’ in which they set up the wishes of their community, according to their financial resources (Borrie and Memon, 2005, p. 3). This planning mechanism gives some power to the communities to act at a local level. Thomas and Memon talk of ‘governance’ (2007, p. 176). Consequently, communities can express their voices through this consultation process to ask for a better local waste management and a better preservation of their townscape and of their local heritage buildings.

General bylaw-making power for territorial authorities
A second mechanism likely to be favourable to the reuse of building products is found in section 143 of the Local Government Act. Local authorities have the opportunity to establish and enforce bylaws as specified in section 145:
A territorial authority may make bylaws for its district for 1 or more of the following purposes:

(a) protecting the public from nuisance:
(b) protecting, promoting, and maintaining public health and safety:
(c) minimising the potential for offensive behaviour in public places.

Therefore, territorial authorities can write bylaws on waste management, including C&D waste management, to minimise nuisance to the public.

**The Resource Management Act 1991**

The Resource Management Act 1991 (RMA) is related to the sustainable management of natural and physical resources (section 5 of the Act). It is under the authority of the Ministry for the Environment and it is implemented by regional councils and territorial authorities. Because reusing building products enables a building to limit its impacts on the environment, the RMA is, in theory, relevant to this study. The Act also gives some attention to heritage and to the preservation of amenity values. Overall, the provisions in this legislation can lead to the need to reuse some building products for cultural, environmental and aesthetic purposes:

6 **Matters of national importance**

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:

(f) the protection of historic heritage from inappropriate subdivision, use, and development

…

7 **Other matters**

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to—

(aa) the ethic of stewardship:

(b) the efficient use and development of natural and physical resources:

(ba) the efficiency of the end use of energy:

(c) the maintenance and enhancement of amenity values:

…

(f) maintenance and enhancement of the quality of the environment:

(g) any finite characteristics of natural and physical resources:

…

(i) the effects of climate change:
In particular, section 2 of the Act provides a definition of the term ‘amenity values’:

amenity values means those natural or physical qualities and characteristics of an area that contribute to people’s appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.

The definitions in the RMA emphasise the protection of the environment, with a responsibility of society for the sustainable management of natural and physical resources (section 5). Energy use and its consequences, the amenity values and heritage buildings are elements that can be better managed by reusing building products, aligning with the philosophy of this Act. This planning legislation comprises some mechanisms, which are examined in the following sections, to achieve the sustainable management of natural and physical resources.

**Policy Statements, Standards, and Plans**

The RMA requires the preparation of regional policy statements and for district plans to guide the local management of natural and physical resources (sections 60; 73(1)). In addition, the RMA offers other optional instruments. This is the case for the national policy statements, the national environmental standards, and the regional plans (except for the coastal plan) which are all optional (sections 45(2); 43(1); 65(1)).

The purpose of the different policy statements, standards and plans is presented in the following table, Table 4.3:
Table 4.3 – Purpose of Instruments Giving Effect to the Resource Management Act 1991

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>National Environmental Standard</strong></td>
</tr>
<tr>
<td>No purpose is explicitly stated but more information on the National Environmental Standards is available in sections 43 and 43A.</td>
</tr>
<tr>
<td><strong>National Policy Statement</strong></td>
</tr>
<tr>
<td>Section 45(1):</td>
</tr>
<tr>
<td>The purpose of national policy statements is to state objectives and policies for matters of national significance that are relevant to achieving the purpose of this Act.</td>
</tr>
<tr>
<td><strong>Regional Policy Statement</strong></td>
</tr>
<tr>
<td>Section 59:</td>
</tr>
<tr>
<td>The purpose of a regional policy statement is to achieve the purpose of the Act by providing an overview of the resource management issues of the region and policies and methods to achieve integrated management of the natural and physical resources of the whole region.</td>
</tr>
<tr>
<td><strong>Regional Plan (except coastal plans)</strong></td>
</tr>
<tr>
<td>Section 63 (1):</td>
</tr>
<tr>
<td>The purpose of the preparation, implementation, and administration of regional plans is to assist a regional council to carry out any of its functions in order to achieve the purpose of this Act.</td>
</tr>
<tr>
<td><strong>District Plan</strong></td>
</tr>
<tr>
<td>Section 72:</td>
</tr>
<tr>
<td>The purpose of the preparation, implementation, and administration of district plans is to assist territorial authorities to carry out their functions in order to achieve the purpose of this Act.</td>
</tr>
</tbody>
</table>

Five National Environmental Standards are currently enforced and four National Policy Statements have been published, although none of them are directly linked with the reuse of building products (Ministry for the Environment, 2011a, 2011b). The Ministry for the Environment has also focused on developing a national policy statement on urban design, but this work is not completed yet. Overall, some regional policy statements, regional plans, and district plans can influence the reuse of building products as they refer to solid waste management or to the protection of heritage. An illustration of this statement is provided in section 4.2.3 where Dunedin planning documents are analysed.

Hierarchy within Policy Statements, Standards, and Plans
According to the RMA, there is a hierarchy of policy statements, standards, and plans. District plans must not be inconsistent with a regional plan (section 75(4)(b)). In addition, district plans must give effect to regional policy statements and national policy statements (sections 75(3)(a); (c)). Regional plans must give effect to national policy statements and
to regional policy statements (sections 67(3)(a); (c)). Regional policy statements must give effect to national policy statements (section 62(3)). According to section 43B(3), “a rule or resource consent may not be more lenient than a national environmental standard”, meaning that rules in district plans and regional plans must give effect to national environmental standards. This hierarchy can be summarised with the following scheme, Figure 4.2:

Figure 4.2 – Resource Management Hierarchy of Policy Statements, Standards, and Plans

Resource Consents
In addition to these plans, resource consent applicants have to lodge their application to a resource consent authority, i.e. the regional council and/or the territorial authority, depending on the nature of the demand. There are five types of resource consents (section 87 of the RMA). Within them, land-use consents and discharge permits can be related to heritage preservation and landfills.

Heritage Orders
The RMA offers mechanisms to ensure the protection of heritage buildings. According to section 187 of the Act, “heritage order means a provision made in a district plan to give effect to a requirement made by a heritage protection authority under section 189 or section
189A”. Moreover, according to section 193 of the Act, the approval of the heritage protection authority is necessary prior to undertaking any work on a protected building which will modify its character. Heritage orders are also referred to in section 5 of the Historic Places Act 1993. With this protection status, reusing building products may allow the preserving of the traditional character of a heritage building. It can therefore be recommended by the relevant authorities.

**Heritage Building Legislation**

The heritage building legislation depends on the RMA and on the Historic Places Act 1993. The RMA and its mechanisms have been presented in the previous section. Therefore, this section only refers to the Historic Places Act 1993.

The Historic Places Act 1993 is a legislative tool designed to conserve New Zealand’s historical and cultural elements. The purpose of the Act is to “promote the identification, protection, preservation, and conservation of the historical and cultural heritage of New Zealand” (section 4(1)). Section 2 provides a definition of the term ‘conservation’, furthering the understanding of the purpose of this Act: “conservation includes the processes of preserving, maintaining, and restoring historic places and historic areas so as to safeguard their historical and cultural values”.

The Historic Places Act is administered by the Ministry for Culture and Heritage and it is managed principally by the NZHPT, the Māori Heritage Council (for issues of Māori interest) and by territorial authorities. This Act presents some mechanisms for the protection of heritage places and for their maintenance. It also details the actions necessary prior to destroying, damaging or modifying any historic place. Consequently, it indirectly provides guidance for reusing salvaged products in heritage buildings.

**Mechanisms under the Historic Places Act 1993**

To preserve and conserve heritage buildings, the Historic Places Act allows the implementation of heritage covenants, which are to “provide for the protection, conservation, and maintenance of that place, area, or wahi tapu” (section 6). Historic places, historic areas, wahi tapus and wahi tapu areas can also be registered to be protected under the RMA (section 22 of the Historic Places Act). In addition, the NZHPT has been established to advocate and help in the preservation of heritage buildings (section 39 of the
In these cases, reusing building products, especially those from heritage buildings, helps to maintain and enhance their heritage.

**Summary of the Planning Legislation:** The Local Government Act 2002, the RMA 1991, and the Historic Places Act 1993 provide a legal framework to encourage the reuse of building products. This activity can be regarded as a means to satisfy the outcomes of local communities. It also aligns with the preservation of the natural and the built environment, especially its heritage components.

**Waste Legislation**

**The Waste Minimisation Act 2008**

The Waste Minimisation Act 2008 is a legislative framework designed to decrease waste production. The purpose of this Act is:

- to encourage waste minimisation and a decrease in waste disposal in order to—
  - protect the environment from harm; and
  - provide environmental, social, economic, and cultural benefits (section 3).

This Act is based on a waste hierarchy according to the definition given to the term ‘waste minimisation’ in section 5 and to the order of the waste management options listed in subsection (b):

- waste minimisation means—
  - the reduction of waste; and
  - the reuse, recycling, and recovery of waste and diverted material.

A better understanding of the waste minimisation concept is given with the definition of the terms ‘diverted material’, ‘reduction’, ‘reuse’, ‘recycling’, and ‘waste’, in the same section:

- diverted material means any thing that is no longer required for its original purpose and, but for commercial or other waste minimisation activities, would be disposed of or discarded.
- reduction means—
  - lessening waste generation, including by using products more efficiently or by redesigning products; and
  - in relation to a product, lessening waste generation in relation to the product.
reuse means the further use of waste or diverted material in its existing form for the original purpose of the materials or products that constitute the waste or diverted material, or for a similar purpose.

recycling means the reprocessing of waste or diverted material to produce new materials.

waste—
(a) means anything disposed of or discarded; and
(b) includes a type of waste that is defined by its composition or source (for example, organic waste, electronic waste, or construction and demolition waste); and
(c) to avoid doubt, includes any component or element of diverted material, if the component or element is disposed of or discarded.

The definition of the term ‘reuse’ in the Act is similar to the definition adopted for this study, in the sense that the activities of reusing and recycling are distinct. Overall, the Waste Minimisation Act is relevant to this research as the reuse of products is a strategy developed to reduce solid waste production. It is enforced mostly by territorial authorities (Part 4 of the Act), although some responsibilities for landfill are incumbent upon the regional councils under the RMA (section 30(1)(f)). Furthermore, the Waste Minimisation Act encompasses some mechanisms to divert waste from landfills. They are detailed in the next sections.

**Product Stewardship**

Part 2 of the Waste Minimisation Act 2008 is specific to product stewardship. Section 8 of the Waste Minimisation Act specifies the purpose of product stewardship:

> The purpose of this Part is to encourage (and, in certain circumstances, require) the people and organisations involved in the life of a product to share responsibility for—
> (a) ensuring there is effective reduction, reuse, recycling, or recovery of the product; and
> (b) managing any environmental harm arising from the product when it becomes waste.

According to sections 9, 10, and 11 of the Waste Minimisation Act, products stewardship schemes are developed for products either because of their priority and hazardous character or because of the benefits associated with their diversion from landfill. These schemes can also be developed on a voluntary basis. Currently, seven product stewardship agreements exist for six types of materials (Ministry for the Environment, 2012). An examination of the existing product stewardship schemes reveals that none is specific to any building material or product. However, such a stewardship could help organise C&D waste.
management. In this case, the reuse of C&D waste would be developed and supervised at a national level by the organisations adopting this scheme.

The Waste Disposal Levy and the Waste Minimisation Fund
A waste levy has been enforced following the adoption of the Waste Minimisation Act. Part 3 of the Act is specific to the Waste Disposal Levy. The purpose of this Part is explained in section 25 of the Act:

The purpose of this Part is to enable a levy to be imposed on waste disposed of to—

(a) raise revenue for promoting and achieving waste minimisation; and
(b) increase the cost of waste disposal to recognise that disposal imposes costs on the environment, society, and the economy.

The levy is collected and redistributed to fund waste minimisation projects. Currently, the sum of NZ$11.50 is collected for the waste disposed in legal disposal sites (Ministry for the Environment, 2011c). This money is shared to recover the administration costs of this system and to promote waste minimisation at different scales (section 30). The Waste Minimisation Fund, managed by the Ministry for the Environment, finances projects achieving waste minimisation and territorial authorities receive a share to encourage it (sections 30(c)(ii); 31).

By raising the price of C&D waste disposal, the government encourages a diversion of waste, supporting indirectly the reuse of building products. In addition, the redistribution of the levy fund allows innovative projects, such as those reusing building products, to be funded with the waste minimisation fund.

Waste Management and Minimisation Plan
Waste management and minimisation plans are mandatory for territorial authorities (section 43(1)). According to section 43(2), they contain objectives, policies, methods to allow for an efficient management of waste, as well as a financial plan supporting their implementation. The plan must also reflect the waste hierarchy specified in the Act (section 44(a)). This requirement means that the reuse of waste has to be considered as a strategy to reduce waste by territorial authorities.
Chapter Four

Reporting and Audits
Part 6 of the Waste Minimisation Act 2008 stipulates that the Governor-General may require any stakeholder in waste management to keep a record of their statistics to measure progress in this field (section 86(1)(b)). This arrangement is not mandatory in the Act and no information is available on the level of details that the Governor-General may require. If on a national scale, a greater emphasis was on C&D waste, the government could use that clause to get a better monitoring of this waste stream.

National Waste Strategy
The latest waste strategy, dated 2010, is very broad and not specific to any kind of waste. The goals are included in the title of the publication The New Zealand Waste Strategy – Reducing Harm, Improving Efficiency (Ministry for the Environment, 2010b). Goal One is to reduce the harmful effect of waste while Goal Two is to improve the efficiency of resource use. This waste strategy is inclusive as it affects the whole society. The reuse of building products is an option that can help improve waste efficiency, the second goal of this waste strategy. It also involves the whole community, from the national government, local government, building and demolition industries, and building owners.

Another emphasis in this waste strategy is the consistency of the waste legislation with other national legislation. It is introduced as ‘the toolkit for managing and minimising waste’. A representation of this legislative framework is displayed in the next figure, Figure 4.3:
The Waste Minimisation Act 2008, the Local Government Act 2002, and the RMA have been presented and analysed in light of the reuse of building products earlier in this section. The Hazardous Substances and New Organisms Act 1996 is specific to hazardous waste, which are not reused as building products. The Climate Change Response Act 2002 is dedicated to the development and implementation of a greenhouse gas emissions trading scheme (section 3). Therefore, the study of these two acts is excluded from the scope of this research.

**Summary of the Waste Legislation:** Currently, one of the two emphases in solid waste management is on waste reduction. Therefore the reuse of waste is indicated as a method to limit the amount of waste landfilled. Furthermore, on a national and legal perspective, the approach to solid waste is inclusive as it refers to all waste, the whole society and is consistent with all national legislation, without discernment. This holistic approach particularly offers opportunities for the reuse of building products to involve the whole community.
4.1.4. Stakeholders Involved or Likely to Be Involved in the Reuse of Building Products

As detailed in section 2.6.1, there is a multitude of stakeholders likely to be involved in the reuse of building products. The building, C&D waste, and demolition industries are the primary stakeholders, although the government and non-governmental agencies can have an input in this activity. A presentation of these stakeholders is provided in the next sections.

**Government**

*The Ministry for the Environment*

The Ministry for the Environment is in charge of environmental concerns in New Zealand. This institution designs environmental laws and provides some policies and strategies applicable on a national scale. It also monitors the state of the environment (Ministry for the Environment, 2011f). The Ministry for the Environment is particularly involved with urban design, sustainable buildings and C&D waste.

*The Urban Design Protocol*

The Ministry for the Environment supports the urban design protocol, published in 2005, which provides guidance to develop urban environments. This guide particularly encourages sustainable building:

> Successful towns and cities enhance these qualities by maintaining and sometimes recreating natural networks throughout their urban areas, and by designing new buildings... that meet the highest standards of sustainable design and construction. (Ministry for the Environment and Urban Design Advisory Group, 2005, p. 14).

This protocol is widely adopted as 185 organisations have registered their interest to it (Ministry for the Environment, 2011d).

*Sustainable Building*

In New Zealand, the Ministry for the Environment has chosen to mention the term ‘sustainable building’ in the two documents that it has published on the topic: *Value Case for Sustainable Building in New Zealand* and *Rethinking our Built Environments: Towards a Sustainable Future* (Fullbrook, Jackson, and Finlay, 2005; Jenkin and Pedersen Zari, 2009).
Chapter Four

*Value Case for Sustainable Building in New Zealand* details the advantages of green buildings, both environmental and economic, with cost and return on investment (Fullbrook, Jackson, and Finlay, 2005). It analyses some New Zealand case studies where sustainable buildings have been commissioned and exposes the lessons learnt from each scenario. A few references are made to the reuse of buildings and to the reuse of C&D waste without however providing any detail on their approach to achieve it.

*Rethinking our Built Environments: Towards a Sustainable Future* is a research document commissioned by the Ministry for the Environment, studying the role of sustainable buildings (Jenkin and Pedersen Zari, 2009). The study connects buildings with their wider environment, and particularly with nature and their occupants. In this document, sustainable buildings’ are differentiated according to their level of sustainability, following the model developed by Reed (2007), including regenerative and restorative design.

Besides these publications, the Ministry for the Environment has worked with many organisations, including the Department of Building and Housing, on the *Smarter Homes* programme to assist in developing sustainable houses.

**C&D Waste**

In its statement of intent for the period 2011-2014, the Ministry for the Environment has declared its commitment to waste minimisation:

> The Ministry will… advise on and implement the Waste Minimisation Act 2008, including collecting and distributing waste disposal levy funds, facilitating product stewardship schemes and facilitating good waste management and minimisation planning by local authorities (Ministry for the Environment, 2011f, p. 14).

This ministry, in particular, plays a role in C&D waste management by defining waste streams, collecting statistics, and releasing guides of good practice for local authorities, members of the waste industry, and individuals (Ministry for the Environment, 2011g). It also works in partnership with other organisations to advise on C&D waste reduction. The programme REBRI is one of these joint ventures; and the Ministry for the Environment refers to it in its C&D waste webpage (Ministry for the Environment, 2010a).
Govt³ Programme
The Ministry for the Environment has been involved with other ministries, in a programme called ‘Govt³’ from 2003 to 2009. On a voluntary basis, some government agencies chose to adopt more sustainability in their offices, allowing the government to take the lead in sustainable building (Office of the Minister for the Environment and Office of the Minister Responsible for Climate Change Issues, n.d.). Cooperation between the Ministry for the Environment and the NZGBC was notably sought to assess the sustainability of their offices (Office of the Minister for the Environment and Office of the Minister Responsible for Climate Change Issues, n.d.).

The Department of Building and Housing
The Department of Building and Housing administers the building legislation (including the Building Act 2004 and the Building Code). It is also involved in the ‘Smarter Homes’ programme, advising individuals on ways to gain more sustainability on their houses.

Smarter Homes
A wide programme on sustainable building, Smarter Homes, is the result of the collaboration of the Department of Building and Housing, the Ministry for the Environment, Beacon Pathway, and BRANZ. The publication Your Guide to a Smarter Home focuses on initiatives to reduce energy consumption (Department of Building and Housing and Consumer, 2008). It is complemented by a website, www.smarterhomes.org.nz providing information for individuals to achieve a more sustainable dwelling.

Although the programme is based on energy consumption, information is also available on on-site waste minimisation. Some examples of good practice are given to reduce waste production during the construction and the deconstruction of a building (Department of Building and Housing, 2007). The reuse of building products is specified on this webpage as an alternative to landfill; and deconstruction and design for deconstruction are advocated.

The position of the Department of Building and Housing towards the reuse of building products is unclear as this activity is accepted as long as the proposed building performances comply with the Building Code. However, the Department of Building and
Housing, in its collaboration with diverse institutions on the *Smarter Homes* publication, promotes this activity.

**The New Zealand Historic Places Trust**
The NZHPT is a crown entity (section 7 of the Historic Places Act 1993). Under this Act, this agency is given some functions, detailed in section 39 of the Act, including identifying New Zealand heritage and participating in its protection. Methods available to it are the establishment of a register of historic places, which is regularly updated, the promotion of heritage places, and the allocation of a fund for heritage places of national significance (New Zealand Historic Places Trust, 2011b). The NZHPT also advises any party requesting information on New Zealand’s heritage. Regarding salvaged building products, the NZHPT sometimes promote their salvaging and their reuse when alterations are proposed for a historic building (Key Informant 10).

**Summary of the New Zealand Government as a stakeholder:** Different organisations from central government are likely to be involved in the reuse of building products. These different departments need to cooperate to develop an approach for this activity as their approach is currently fragmented.

**Non Government Agencies Involved or Likely to be Involved in the Reuse of Building Products**

**The Building and Research Association of New Zealand**
BRANZ is an organisation resulting from an agreement between the building industry and the government (Building Research Association of New Zealand, n.d.-f). This organisation’s particular research is on building in general, sustainable building with its programme LEVEL, and on C&D waste with its programme REBRI. These two programmes are analysed in the next sections. BRANZ also has an educational purpose as it informs the building industry on building news through their magazine ‘Build’, organises seminars, and publicises reports (Building Research Association of New Zealand, n.d.-a). BRANZ also educates the wider public with its involvement in the eco design advisors programme, as discussed later.
LEVEL
Level is a programme developed by BRANZ for the building industry to adopt sustainable practices. A section of its website is dedicated to material use, with notably a subsection on reuse and recycling. Reusable products are listed and a checklist is provided to select them (Building Research Association of New Zealand, n.d.-h). Within the subsection ‘choosing materials’ from the section ‘material use’, the reuse of building products is suggested, among other criteria (Building Research Association of New Zealand, n.d.-c). Furthermore, the webpage on embodied energy provides some information aligning with design for deconstruction (Building Research Association of New Zealand, n.d.-e). On the reuse and recycling webpage, reference is made to the programme REBRI, which is detailed in the next section.

REBRI
Resource Efficiency in the Building and Related Industries (REBRI) is a programme developed by BRANZ, local councils, central government, and building industries to minimise building related consumptions (Building Research Association of New Zealand, n.d.-b). The emphasis of this programme is on C&D waste. As introduced in Chapter One, reusing building products is acknowledged as an activity to reduce C&D waste production in the ‘DESIGN AND PLANNING – waste reduction’ guide (Building Research Association of New Zealand, 2005). This activity is also encouraged in the REBRI Waste Management Plan, where it is listed along with the recycling of building materials as an option to divert C&D waste (Building Research Association of New Zealand, n.d.-g).

Eco Design Advisor
BRANZ has developed the concept of eco design advisors in New Zealand and educates these professionals (Building Research Association of New Zealand, n.d.-d). They are based in some local authorities and advise ratepayers how to achieve sustainability in their building. Currently, seven councils have an eco design advisor (Building Research Association of New Zealand, 2008). In accordance with the national priorities on sustainable building, efforts are usually based on insulation and energy conservation, but do not exclude advice on material choice (Building Research Association of New Zealand Ltd, 2008).
The New Zealand Green Building Council
The NZGBC is an organisation carrying out research on achieving more sustainability in the building industry. It is part of a worldwide network: the World Green Building Council, which gathers together green building councils from different countries (New Zealand Green Building Council, 2011d). Efforts are based on developing rating tools to assess the sustainability of buildings and to influence the design of future buildings. The NZGBC has developed a Green Star rating tool for commercial buildings and a Homestar rating tool for dwellings. According to the self-assessment guide available on the internet, Homestar has no reference to any topic related to the reuse of building products (New Zealand Green Building Council, 2010). As a consequence, only the Green Star Rating Tool is presented in the following section.

Green Star Rating Tool
According to Storey and Keane (2008), the New Zealand Green Star rating tool is modelled on the BREEAM, the USA LEED, and the Australian Green Star schemes. It consists of the assessment of a building project under eight categories: management, indoor environment quality, energy, transport, water, materials, land use and ecology, and emissions; and a supplementary category ‘innovation’ is optional (New Zealand Green Building Council, 2011c). It is currently available for three types of buildings: offices and office interiors, industrial buildings, and buildings for educational purposes (New Zealand Green Building Council, 2011a).

The Green Star Rating Tool and the Reuse of Building Products
The Green Star rating tool for offices - 2009 is analysed in this paragraph with the Office 2009 - OFFICE summary document (New Zealand Green Building Council, 2009). This rating tool is developed for new and existing office buildings. It includes some minimal requirements that a building project must meet for a building to be certified.

The material category amounts to 10% of the total score. In the section ‘management’, criterion ‘MAN-5’ relates to waste management. Its aim is to “encourage and recognise management practices that minimise the amount of construction and demolition waste going to disposal” (New Zealand Green Building Council, 2009, p. 2). Up to three points are available under this criterion. The contractor has to adopt a waste management plan and be committed to reuse or recycle at least 30, 50 or 70 percent of waste by weight to
obtain one, two or three points. Buildings with a building contract value under $50,000 are excluded from this criterion.

Criterion ‘MAT-6’ relates to timber. Its aim is to “encourage and recognise the re-use of timber, timber from certified sustainably managed forests, and reduction in the inappropriate use of treated timber” (New Zealand Green Building Council, 2009, p. 13). Up to three points are available for this criterion if the amount of timber used in the project is significant and one or two points are available when 50% to 90% of the timber used is:

- Re-used timber
- Post-consumer recycled timber
- Independently certified as having lower environmental impact than standard timber, as verified through a materials certification body recognised by the NZGBC (New Zealand Green Building Council, 2009, p. 13).

Up to five points are available in the category innovation, which distinguishes innovative strategies and technologies, exceeding green star benchmark, and environmental design initiatives. An application for any of these criteria is examined by the NZGBC Technical Sub Committee.

Although some considerations are given to C&D waste management and to the reuse of building products, their participation in the final score defining the sustainability of office buildings is relatively low, and does not strongly encourage this activity.

Universities
All the universities in New Zealand are involved in sustainable building. The University of Otago, Massey University and the University of Canterbury are education sponsors of the Green Star while some staff members from Victoria University and the University of Auckland have presented some papers during the sustainable building 2010 conference (New Zealand Green Building Council, 2011b). The Centre for Building Performance Research from the School of Architecture of Victoria University Wellington has carried out particular research on embodied energy and its CO₂ equivalent, and on the efficient use of building products (Alcorn, 1996; Storey, et al., 2005).

Some partnerships and networks exist in carrying out research on sustainable building. For example, the New Zealand Centre for Sustainable Cities gathers many partners, such as universities, research organisations and local authorities (The New Zealand Centre for
Sustainable Cities, n.d.). Diverse departments from universities are involved in this type of research, including marketing/business, planning, legislation and applied sciences (The New Zealand Centre for Sustainable Cities, n.d.).

The Building and Construction Industry Training Organisation
The Building and Construction Industry Training Organisation (BCITO) is in charge of implementing qualifications for the building industry (Building and Construction Industry Training Organisation, 2010). It has developed a training programme and a specific book for its apprentices (Key Informant 15). According to Key Informant 15, within this documentation, a chapter is dedicated to non-traditional building works, including buildings made out of uncommon materials, such as mud bricks. The training programme and the documentation provided by this organisation to their apprentices can raise the awareness of future builders on sustainable building, C&D waste minimisation, and on the reuse of building products.

The Sustainable Habitat Challenge, known as SHAC
The Sustainable Habitat Challenge (SHAC) gathers educational organisations interested in building sustainably, with simplicity or affordability (Bishop, 2011). Some educational organisations have participated in the challenge by organising the construction of a sustainable building and by gathering different types of building professionals together. In Dunedin, the University of Otago and the Otago Polytechnic are involved in this challenge (Sustainable Habitat Challenge, 2009).

Criteria for the 2009 challenge notably included material choice, and waste minimisation. Materials had to be sustainably sourced: “re-used, recycled or made from renewable resources” (Sustainable Habitat Challenge, 2008, p. 2). The waste criterion has been developed for the construction and the operation stages of the building (Sustainable Habitat Challenge, 2008). As a result, this programme integrates the reuse of building products as an experience for students and researchers and can present successful opportunities to employ salvaged building products.

The Waste Management Institute of New Zealand
The Waste Management Institute of New Zealand, known as WasteMINZ, is a not for profit organisation providing information to the waste industry and it hosts a network of waste stakeholders. It releases a publication ‘Waste Awareness’ five times a year and
organises workshops and conferences on waste management. It has a group working on ‘life after waste’ (Waste Minimisation New Zealand, 2001). In 2001, a report was published on this concept, but the authors adopted a holistic view and did not focus on C&D waste. Another group is working specifically on C&D waste but no information is available on the reuse of this waste stream (Waste Minimisation New Zealand, n.d.).

**Zero Waste New Zealand Trust**
The Zero Waste New Zealand Trust is an organisation created to raise awareness and educate society on waste production. It also encourages local authorities to adopt a ‘zero waste target’ approach to their waste management by 2015 (Zero Waste New Zealand, 2011). Among the measures suggested to attain this objective are: a better design of products to allow for their waste diversion, encouragement to reuse materials, and the recovery of resources (Zero Waste New Zealand, 2012a). The group has a webpage on C&D waste, but C&D waste information is limited to links to other institutions (Zero Waste New Zealand, 2012b).

**Summary of Non Government Agencies:** Many non government organisations are likely to promote the reuse of building products. They have either a primary focus on building or waste. Some of them already consider the use of salvaged building products but do not define a complete framework for this activity. They particularly do not provide a clear explanation of the advantages of adopting this activity, the precautions and the way to use salvaged products. These organisations usually have an interest in educating the building community or society in general. They also research opportunities to either minimise waste production, or how to modernise the building industry. These organisations have the opportunity to adopt a research and educational role that promotes positively the reuse of building products.

### 4.2. Dunedin

#### 4.2.1. Overview

This research case study is based in Dunedin, a city located in the South East of the South Island of New Zealand. It is the second largest city in the South Island, with a population of 118,683 according to the 2006 Census; this represents about three percent of New Zealanders (Statistics New Zealand, 2006). Dunedin is administered through the Otago
Regional Council (ORC) and through the DCC, depicted in the following figure, Figure 4.4:

Dunedin is a city with many heritage buildings. This is explained by the economic development of the area resulting of the gold rush, followed by an economic downturn, which prevented these original buildings being replaced by more recent ones (Entswisle, 2011). Today, this heritage is identified as a significant character of the city: “heritage is widely recognised as an important element in defining the character and identity of Dunedin and its hinterland, in contributing to the unique ‘sense of place’ associated with the city, and providing a tangible link with the past” (Dunedin City Council, 2007, p. 6). It also plays a major economic role, being an asset for tourism (Dunedin City Council, 2007).
However, heritage buildings are at risks in the city. Currently, some heritage buildings in the city centre are affected by ‘demolition by neglect’ (Loughrey, 2011). Either way, if heritage buildings are preserved, they might need to be maintained or renovated with recovered heritage building products; and if a heritage building ends up being demolished, an opportunity exists in recovering the maximum amount of its reusable products to be used in another building needing repair.

4.2.2. Profiles

Overview of the Building Industry

Statistics
Table 4.4 provides a comparison of the Dunedin building activity within the New Zealand building activity. According to this data, since 2009, the activity in the Dunedin building industry is representative of the national building activity; the percentage of building consents granted in Dunedin compared to nationally is similar to the percentage of the local population within the country. However, the value of Dunedin buildings is usually inferior to the average national value of buildings (except for 2010).
Table 4.4 - Comparison of the Activity of the Dunedin Building Industry and the New Zealand Building Industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Dunedin</th>
<th>New Zealand</th>
<th>% Dunedin/NZ</th>
<th>Dunedin</th>
<th>New Zealand</th>
<th>% Dunedin/NZ</th>
<th>Dunedin</th>
<th>New Zealand</th>
<th>% Dunedin/NZ</th>
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<td>14643</td>
<td>2.16</td>
<td>198.5</td>
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<td>104</td>
<td>5820</td>
<td>1.79</td>
<td>1666</td>
<td>56908</td>
<td>3.50</td>
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<td>13540</td>
<td>2.63</td>
<td>333</td>
<td>9520</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>1236</td>
<td>37482</td>
<td>3.30</td>
<td>82.4</td>
<td>4870</td>
<td>1.69</td>
<td>1582</td>
<td>50302</td>
<td>2.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>346</td>
<td>12820</td>
<td>2.70</td>
<td>199.4</td>
<td>8610</td>
<td></td>
</tr>
</tbody>
</table>

According to Lloyd (2005), the decreasing number of inhabitants in Dunedin since the Gold Rush in 1860s has meant a low construction rate for new dwellings. This information suggests that in Dunedin, the building activity focuses more on alterations, and repairs to existing buildings than in the construction of new buildings (Lloyd, 2005). This is confirmed by the higher number of building consents issued for alterations than for construction of buildings (Statistics New Zealand, 2011c).

**Sustainable Building**

Dunedin, like New Zealand, prioritises energy efficiency in sustainable building with the insulation of dwellings given its climate and the general lack of insulation in residential buildings. Indeed, Lloyd characterises the dwellings as “old, even by New Zealand Standards, with… 86% of homes being constructed before the national insulation standards were introduced in 1977” (Lloyd, 2005, p. 43).
Overview of C&D Waste Production

The DCC is engaged in reducing the amount of waste it landfills to nil by 2015 following its commitment to the Zero Waste programme (Zero Waste New Zealand, n.d.). According to the information provided by Key Informant 6, C&D waste amounts for about 30 to 50% of the total waste production in Dunedin. These statistics correlate the literature on worldwide C&D waste production and suggests that locally, the priority in solid waste management should be on C&D waste reduction.

Overview of the Demolition Industry

In Dunedin, draft data provided by the DCC indicates that 30 dwellings have been demolished in 2010 and that the average local demolition rate over the last four years is 31 residential properties. No other information is available on this industry.

Summary of section 4.2.2: The situation in Dunedin is relatively similar to the national context. The local building activity is, on average, reflective of the national activity and C&D waste is a significant stream accounting for local solid waste.

4.2.3. Relevant Legislation

Stakeholders in Dunedin are subject to the New Zealand legislation developed in section 4.1.3. However, these local stakeholders also have to comply with the local legal framework developed by both the ORC and the DCC. Dunedin local authorities give effect to the Building Act, the Local Government Act, the RMA, and the Waste Minimisation Act. Their approach to comply with national legislation is analysed in the following sections.

Local Mechanisms Giving Effect to the Building Act 2004

To give effect to the building legislation, the building consent authority processes the building consents, inspects the building work and delivers a code compliance certificate (section 12(1) of the Building Act 2004). In Dunedin, the building consent authority for building work is the DCC. According to Key Informant 6, the DCC does not require any waste management plan for a building consent application.
Local Mechanisms Giving Effect to the Local Government Act 2002

The Long-term Council Community Plan from the Otago Regional Council

The Otago Regional Council Community Long Term Plan 2009-2019 states that the consultation process with the community has resulted in six outcomes. The reuse of building products has the opportunity to align with three of them: ‘the sustainable use of resources for prosperity in Otago’, the preservation of the ‘diverse landscapes that say Otago’, and ‘Otago values its heritage’ (Otago Regional Council, 2009).

The Long-term Council Community Plan from the Dunedin City Council

The Dunedin City Council Community Plan states that the community has asked for many improvements in the city, including more sustainability, more opportunities for waste minimisation, a better promotion of the city as a place full of heritage, and a better heritage management (Dunedin City Council, 2009). Reusing building products can help fulfil these community wishes.

The Dunedin City Solid Waste Bylaw 2002

Under the Local Government Act 2002, the DCC has a solid waste bylaw, whose scope is to “regulate the collection and disposal of solid waste in Dunedin City” (section 6.1). According to section 6.2,

(1) The objectives of this Bylaw are:

- To ensure that refuse is collected and disposed of in an efficient and cost effective manner and also to ensure that the obstruction of Dunedin City streets by refuse is kept to a minimum.
- To regulate the collection and disposal of refuse in such a way as to encourage minimisation of the quantity of refuse being generated and disposed of in Dunedin City.

(2) General issues such as recycling, refuse storage and waste management are also covered by this Bylaw.

The philosophy of this bylaw is related to the nuisance due to waste disposal and collection, in agreement with section 145 of the Local Government Act. According to Key Informant 6, it is currently not enforced and the DCC does not plan to implement it as its wording is too loose.
Local Mechanisms Giving Effect to the Resource Management Act 1991

The ORC and the DCC are the resource consent authorities in Dunedin. They also have a regulatory role by establishing policy statements and plans.

The Otago Regional Policy Statement

The ORC, through the RMA, has the power to control the discharges of contaminants into the environment. The Otago Regional Policy Statement provides direction for the sustainable management of local physical and natural resources. In its policy statement, approved and operating since 1998, the ORC considers waste as a contaminant and identifies waste as an issue of regional significance. The definition of waste is broad, including solid, liquid, and gaseous waste. In this document, the emphasis is on the pollution generated by waste disposal into the environment.

The ORC lists the reuse and recycling of waste as one of the three strategies of an integrated waste management system, early in Chapter 13: Waste and Hazardous Substances. This document gives a framework for a better recovery and reuse of waste, as it identifies this waste management option as an opportunity to decrease the amount of waste produced in Otago. Generally, several methods are suggested to decrease waste production in the Otago Regional Policy Statement, including more education, research, and collaboration between the relevant stakeholders.

The Otago Regional Plan: Waste

The Otago Waste Regional Plan, which focuses on solid waste, was approved in 1996 and has been operating since 1997. Waste minimisation is listed as one of the purposes of the plan (section 1.3 of the Plan) and a chapter is dedicated to this waste strategy. The Otago Regional Plan: Waste is consistent with the Otago Regional Policy Statement and displays an objective and a policy explicitly encouraging the reuse of waste, while not being specific to C&D waste (objective 4.3.2 and policy 4.4.2). Although, some waste minimisation issues, objectives, policies, and methods are stated in this plan, it does not include any waste minimisation rules. The argument for this, put forward by the ORC, is the inefficiency of a regulatory system at a regional level to minimise waste production.

According to this regional plan, cleanfills are a permitted activity (Rule 7.6.3), without any volume restriction, contrary to many regions in New Zealand (Sinclair Knight Merz, 2010). According to a survey by Sinclair Knight Merz for the Ministry for the
Environment, all councils, except Otago and three others, “monitor actively consented disposal sites (included cleanfills where they are consented)” (Sinclair Knight Merz, 2010, p. 10). This situation demonstrates the lack of involvement of the ORC in C&D waste management, potentially preventing a better awareness on C&D waste significance in Dunedin.

**The Dunedin City District Plan**

The DCC has released its Dunedin City District Plan in 2006. This document presents the mechanisms adopted by the local authority to preserve its townscape, local heritage precincts and heritage buildings. Chapter 13 ‘Townscape’ identifies some townscapes to be preserved within the city and Schedule 25.1 lists the significant buildings and structures contributing to Dunedin’s townscape. Therefore, two ways exist to protect a heritage building through this district plan: scheduled building and building within a heritage or townscape precinct.

The introduction of the Chapter ‘Townscape’ of the district plan stipulates that the:

- Sustainability of that [townscape] character requires consideration of the effects of:
  - alterations to the external appearance of buildings
  - demolition and removal of buildings
  - constructing new buildings
  - transportation routes and vehicles generally.

Several objectives, policies, methods, and anticipated results in this chapter are relevant to the reuse of building products as a way to protect heritage townscapes and places (including buildings), and to conserve the Dunedin City townscape character with its amenities. Rule 13.7.1 details the permitted activities on buildings listed on Schedule 25.1 and on buildings located within a townscape or heritage precinct. Rules 13.7.1(i)(d) and Rule 13.7.1(ii)(d) have the same wording and authorise the reuse of building products for amenities purposes:

- Works on buildings, parts of buildings and other structures where the work is for the sole purpose of restoration or repair of any existing fabric or detailing thereof. Such works shall be undertaken using the same type of material to that originally used and must retain the original design of the feature under repair. In relation to this rule, ‘original’ refers to the condition of the building or structure prior to the repair works being commenced.
Rule 13.7.2 on controlled activities indirectly allows for the reuse of building products in new buildings within a townscape or a heritage precinct to preserve it:

The following activities are controlled activities:

(i) The erection of any new building within townscape and heritage precincts is controlled in respect of:

(a) External design and appearance of the building, including building material and external colour.

Rule 13.7.3(iii) refers to the removal or demolition of a building or a part of it situated in a precinct defined in Chapter 13. There is no mention in this rule of an obligation to recover building products to decrease the amount of C&D waste landfilled, although one of the assessment criteria of the consent authority to grant the permit is the reusability of the whole building.

As presented in the operative Dunedin City District Plan 2006, reusing building products can play a significant role when repairing and maintaining a heritage building and consequently has an impact on the townscape and on the amenity values of a heritage building when used on the exterior of these types of buildings.

**A Heritage Strategy for Dunedin City**

In 2007, *The Heritage Strategy for Dunedin City* was released. It offers a global vision on heritage for the city. The identification of issues, the setting up of goals, with indicators and actions provide a framework to guide the preservation of historic elements (Dunedin City Council, 2007). The DCC calls for team work, involving different organisations and the building owners. It also lists the different roles it has regarding heritage, as detailed in the following table, Table 4.5. The NZHPT also plays a role in the preservation of heritage buildings, according to section 193 of the RMA.

<table>
<thead>
<tr>
<th>Role</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulator</td>
<td>With the Dunedin City District Plan</td>
</tr>
<tr>
<td>Funder</td>
<td>Economic incentives to building owners</td>
</tr>
<tr>
<td></td>
<td>Staff dedicated to heritage buildings</td>
</tr>
<tr>
<td>Promoter and Facilitator</td>
<td>Information made available to the community</td>
</tr>
<tr>
<td>Provider</td>
<td>Lead by maintaining its heritage buildings</td>
</tr>
</tbody>
</table>

Table 4.5 - Roles of the DCC within Heritage Preservation (Adopted from Dunedin City Council, 2007)
In this document, the demolition of heritage buildings is considered to be a high risk in Challenge 1 (Dunedin City Council, 2007). However, no measure is suggested to salvage as many building products as possible if the protection status of the heritage building fails and its demolition is planned. The only type of reuse suggested in this strategy is the adaptive reuse of buildings, considered as a method to better protect this heritage.

*The Heritage Strategy for Dunedin City* is favourable to the reuse of building products. Action 1.3.8 calls for it: “using best practice conservation… as far as is possible, any repairs to heritage buildings should be undertaken using similar materials to the original” (Dunedin City Council, 2007, pp. 18-19). In addition, a selection of actions has been listed to give economic support to heritage building owners who restore, repair, and enhance their buildings.

### Local Mechanisms Giving Effect to the Waste Minimisation Act 2008

*The Resource Recovery and Waste Management Strategy*

In 2006, the DCC published a waste strategy, in agreement with section 286 of the Local Government Act 2002. It is considered as a waste management and minimisation plan, following section 43(4) of the Waste Minimisation Act 2008. In this document, the DCC specifies the different roles it plays in solid waste management, as presented in the following table, Table 4.6.

<table>
<thead>
<tr>
<th>Role</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulator</td>
<td>Development of a waste bylaw</td>
</tr>
<tr>
<td>Service Provider</td>
<td>Provides waste collection, transport and facilities</td>
</tr>
<tr>
<td>Community Leader</td>
<td>Education of society on waste issues and adoption of good practice for this organisation</td>
</tr>
<tr>
<td>Advocate</td>
<td>Promoting waste minimisation</td>
</tr>
<tr>
<td>Financier</td>
<td>Investment in initiatives to minimise waste production</td>
</tr>
</tbody>
</table>

In this waste strategy, the DCC identifies the six main waste issues facing Dunedin, including solid waste reduction and residual solid waste disposal. Their approach is broad as all types of waste are considered: liquid, solid, and gaseous, and from all origins:
domestic and industrial. The local authority also acknowledges in this document the role of institutions and businesses in the minimisation of waste produced.

The first strategic initiative identified in this strategy is the ‘resource recovery and waste minimisation’ (Dunedin City Council’s Resource Recovery and Waste Working Party, 2006, p. 21). Nine targets are presented for this issue. Among them, targets 1, 2, 6, and 7 are relevant to the reuse of building products. They refer to the need for research to recover and minimise waste, the implementation of a maximum ratio target for the amount of waste landfilled in a five year period, the improvement of the waste management of the private sector, and the improvement of the management of C&D waste.

Targets from other strategy initiatives complete the framework relevant to the reuse of building products in the Dunedin waste strategy. Target 22 prescribes the monitoring of waste in Dunedin. Target 24 highlights the role of the DCC as a leader advocating good waste management practice within its organisation, suggesting that the DCC could take the lead in reusing building products locally. Target 28 refers to the economic factors that the DCC can develop to influence waste management.

**Summary of section 4.2.3:** The local legislation is administered by the ORC, the DCC, and the NZHPT. These organisations play a role in solid waste management, heritage protection, and in the preservation of Dunedin townscape. Dunedin advocates for the diversion of waste and for the protection of heritage buildings but its approach is fragmented as it has not yet developed a coherent policy to embed these concepts together. The local planning legislation is broad, as it encompasses solid waste management, and preservation of townscape. Reusing building products emerges as a strategy, that aligns with many of the objectives set by the Dunedin local government.
4.2.4. Stakeholders Involved or Likely to Be Involved in the Reuse of Building Products

The Otago Regional Council
The ORC is involved in writing regional policy statements and regional plans. Its role in waste management and in waste reduction is limited, as it has chosen not to monitor the amount of C&D waste landfilled. Its role in heritage is also limited as the DCC and the NZHPT are the main organisations in charge of this.

The Dunedin City Council
The DCC plays many roles relevant to the reuse of building products. It has a regulatory role as it has developed the Dunedin City Solid Waste Bylaw 2002. It is also both a resource and a building consent authority. This local authority also plays an informative role. For example, the DCC can inform anyone on the disposal centres for some categories of waste, such as demolition waste. It also manages a waste exchange materials list, as detailed in the following section (Key Informant 6). It offers a course on sustainability to its population, as discussed later, but does not provide the services of an eco-design advisor. DCC staff also advise heritage building owners on the opportunities they have to renovate their property (Key Informant 5).

The DCC has a funding role as it has developed a financial support to promote the maintenance of heritage buildings. Consequently, it has the opportunity to subsidise the use of salvaged building products to preserve the look of local heritage buildings. This role is later detailed with the funding role of the NZHPT.

The Waste Exchange Materials Website
The DCC has supported the development of a website, which lists materials for exchange: http://freeresources.co.nz (Forsman, 2011). It classifies the products on offer and in demand according to their nature. One of these categories is specific to C&D waste. This website fully informs traders by providing information on the quantity and quality of the products as well as the frequency of delivery.
**Sustainability Courses in Dunedin**

The DCC subsidises an 8-week sustainability course to its community. This course is developed within a national programme (Key Informant 8). In the past, another session on eco-building was taught. This resulted in two sessions being relevant to the reuse of building products: the waste reduction and the eco-building sessions. The themes developed in the eco-building session were energy generation and sustainable building, with a definition of this concept, an emphasis on insulation, and the delivery of guidance to organise renovations and optimise building work. The session on waste reduction focuses on household waste and is not specific to C&D waste.

Key Informant 8 has stopped teaching the session on eco-building because they felt that the course was getting too long. This informant acknowledges that the eco-building topic is so broad that it is difficult to cover all its facets in a limited time. Nevertheless, this session might be reprogrammed in the future, either in the 8-week course or as a one-off lecture (Key Informant 8).

**The New Zealand Historic Places Trust**

Building products can be reused to maintain the heritage and cultural character of a building. Some economic incentives from the NZHPT and other organisations, as detailed in the next section, are available in New Zealand and Dunedin to help building owners renovate and maintain their property. The NZHPT has an Otago office participating in the promotion of heritage buildings in the region. It promotes heritage buildings and, in particular, works with the DCC on an award and on the distribution of grants to maintain heritage properties, as discussed later.

**Funds Available for Heritage Buildings, in Partnership with the New Zealand Historic Places Trust**

Some funds are available for the owners of a heritage building to repair and maintain their property. The National Heritage Preservation Incentive Fund is administered by the NZHPT for heritage buildings that are nationally significant. The annual fund is $563,000 (New Zealand Historic Places Trust, n.d.). Another fund available for heritage buildings in Dunedin is the Dunedin Heritage Fund. It is the result of the collaboration between the DCC and the NZHPT (Dunedin City Council, 2010). These funds can potentially influence the reuse of products to preserve heritage buildings.
The Dunedin Heritage Re-use Award in Partnership with the New Zealand Historic Places Trust

The DCC has developed the Dunedin Heritage Re-use Award to encourage an adaptive re-use of heritage buildings, in agreement with the Dunedin Heritage Strategy 2007 (Dunedin City Council, 2011b). This strategy helps to maintain and enhance the amenity values associated with heritage buildings. It also acknowledges the work of stakeholders involved in these successful projects, where salvaged building products are sometimes used to repair and retrofit these buildings.

The University of Otago

Environmental Sustainability Advisory Committee

In 2009, the University of Otago created an Environmental Sustainability Advisory Committee to be in charge of all sustainable issues related to the university. It provides information to the Vice-Chancellor and encourages sustainability for all its activities on the campus, whether it be research or education (University of Otago, n.d.-c). This committee could be involved in the promotion of more sustainable buildings within the University campuses.

Sustainable Design in Courses

The University of Otago provides some courses on environmental design within the department of applied sciences (University of Otago, n.d.-b). The law department is also involved in sustainable building as some research has been published on the opportunities to encourage this concept within the RMA (Warnock, 2007; Warnock, 2005). Educating future professionals to be creative and to consider uncommon practices that align with sustainable development is a challenge that the University of Otago can include in their courses so that future building professionals accept and become eager to reuse building products.

Campus Master Plan

The campus master plan realised for the University of Otago provides guidance for the development of the university’s campuses over the next 25 years. It advises sustainability on the campuses as an educational process for the Dunedin community (University of Otago, n.d.-a). In Chapter 10 Sustainability of this document, the eleventh recommendation...
is for the university to use sustainable materials. Consequently, the use of salvaged products in the buildings within the campuses is consistent with the campus master plan.

**Sustainable Buildings for the University**
The University of Otago adopts environmentally sustainable design for any new significant building project. It has recently commissioned the construction of three sustainable buildings (University of Otago, n.d.-d). The William James (Psychology 3) Building has been particularly designed according to the NZGBC guidelines and has been granted five out of six stars meaning that it is a sustainable building of ‘New Zealand Excellence’ (New Zealand Green Building Council, 2011a). This will to develop the Dunedin campus using best practice demonstrates the leadership of the University on sustainable building. It suggests that this stakeholder has the opportunity to play a leading role by demonstrating examples of good practice to other building owners.

**The Otago Polytechnic**

**Sustainable Habitat Challenge**
The Otago Polytechnic is highly involved in the Sustainable Habitat Challenge as one of the Otago Institute of Design staff is the coordinator of this programme (Birnie, *et al*., n.d.). In addition, this programme is valued by two of the Otago Polytechnic departments as building and architectural designs students and carpentry students participate in this challenge (Otago Polytechnic, n.d.-b).

**Business for Change**
The Otago Polytechnic has developed a local network of stakeholders to discuss the concept of local waste. According to the minutes of these meetings, staff from Otago Polytechnic, the University of Otago, consulting companies, and building and waste companies discusses waste issues in Dunedin with sometimes other national stakeholders (Otago Polytechnic, n.d.-a). Discussions can be diverse, embracing the social, environmental, and economic aspects of waste. The outcomes of these meetings can result on the development of waste minimisation strategies.
Summary of section 4.2.4: Similar to the national context, Dunedin stakeholders involved, or likely to be involved, in the reuse of building products are multiple. They have formed a network where they can discuss waste issues, identify opportunities, and develop recommendations.

4.3. Summary
This chapter has set up the context for the reuse of building products in New Zealand and in Dunedin. Objective One ‘to investigate to what extent the building industry in New Zealand currently reuses products’ and Objective Two ‘to identify the barriers against and the opportunities for the effective reuse of products in the Dunedin building industry’ are partially addressed in this chapter. A presentation of the New Zealand context has been provided, with the profile of the key activities linked with the reuse of building products. Then, the national legislation and its mechanisms have been introduced. Finally, the stakeholders involved or likely to be involved have been presented. The same outline has been repeated for the context in Dunedin.

The salient points from this chapter are that insufficient data exist on deconstruction and on C&D waste at the moment in New Zealand, potentially limiting their significance. New Zealand legislation is mainly supportive of the reuse of building products, except the building legislation which can prevent building products being reused in the structure of buildings. However, many opportunities are identified in the Dunedin context; the presence of many heritage buildings can influence a greater reuse of building products, for heritage preservation and to maintain the townscape of the city. In addition, many instruments exist in Dunedin and, are available to be used, as a means to educate society on this activity and to establish the base for the trading of salvaged building products. Many stakeholders also have the opportunity to play a significant role in promoting the reuse of building products, and some of them are already meeting to discuss these opportunities. The next chapter introduces the findings of this research.
Chapter Five presents and discusses the results of the study according to Objective One ‘to investigate to what extent the building industry in New Zealand currently reuses products’. This chapter is therefore mainly descriptive. It illustrates the results provided by the key informants interviewed in light of the findings from the literature review. In this chapter, an overview of the reuse of building products in Dunedin is presented, filling a gap in the literature. This current lack of information on this topic explains that the opinions of key informants are not always confronted by the findings of the literature. In addition, some informants have sometimes expressed opinions that do not reflect the position of the organisation they work for. Following their request, these people remain anonymous when they express their personal opinion in the two following chapters.

From a worldwide perspective, there is confusion of the meaning of the terms ‘reuse’ and ‘recycling’ from academics (Hobbs, 2011a). The same situation occurs in New Zealand where many interviewees do not differentiate the meaning of these two activities and use one word for the other (Key Informants 2; 5; 9; 10; 11; 12; 13; 14; 15). The researcher advises the reader to be aware of this fact and to interpret the quotations of key informants using the word ‘recycling’ instead of the word ‘reuse’ accordingly.

This chapter is divided in three parts: section 5.1 describes the extent to which the building industry reuses building products in Dunedin. Section 5.2 details the sectors relevant to this activity and section 5.3 summarises these findings.

5.1. Extent to Which the Building Industry in Dunedin Currently Reuses Products

Objective One seeks to get an understanding on how common, reusing of building products is in Dunedin. It also aims to provide a snapshot of this activity, by defining how it occurs and by presenting the building products which are worth reusing.
5.1.1. Salvaging Past Practice

The reuse of building products is a traditional activity all over the world (Litchfield, 1983). However, interest in it has decreased for diverse reasons including progress and fashion (Gorgolewski, 2008). In the past thirty years, salvaging and reusing building products were not always common activities in New Zealand. A testimony, from a Wellington perspective, corroborates that there was little awareness on product recovery from the building industry, as provided by Key Informant 15:

I remember in Wellington, in the 1980s here, they took down a lot of buildings. Wellington was like a demolition city. There was no recycling. Things just got taken to the dump. There are stories of people who were in on the job and got stuff. But there is a lot of stuff that just disappeared.

Despite this general lack of awareness of the value of recoverable products, there were some exceptions. Key Informant 7 illustrates the situation from personal experience:

The earliest that … we used some cut stones twenty five years ago, down the Taiaroa Head for a building down there. Those cut stones originally came from Bond Street. They were taken by the DCC and put in the tip. We happened to know they were there. We needed cut stones so we went to the tip and took these products from the tip for free and put them down in Taiaroa Head. Since then, the products have been given a value and they are generally used much more widely around in town.

From a Dunedin demolition company’s point of view, recovering products has always existed, whether it is timber, bricks or concrete, although the amount of product recovered has progressively increased (Key Informant 17).

5.1.2. Current Practice

Reusing Building Products, Infrequent or Common Practice?

Reusing building products is not a common activity on an international, national, and local scale. The literature review has located countries such as Canada and the United States of America where salvaged building products are partially used to erect some buildings (Public Architecture, 2010). From a national perspective, the reuse of building products is an uncommon activity in New Zealand, and there is no national strategy to encourage it (Storey and Keane, 2008). Storey and Keane (2008) use the expression ‘cherry picked elements’ to refer to the elements reused, suggesting that this activity is exceptional (Storey and Keane, 2008, p. 46). The interviewees who have discussed this point agree that reusing products is an uncommon activity in the building industry (Key Informants 1; 2; 4;
110; 13; 14). Key Informant 2 states that few people apply for a building consent involving a reuse of products while Key Informant 12 and 13 concede explicitly that it is not common practice.

Some of the key informants who are familiar with the reuse of building products have expressed how often they carry out this activity. Key Informant 1, 4, and 9 acknowledge that they have reused products in the past and Key Informants 12 and 13 currently reuse building products in their heritage buildings. Key Informant 1 avoids reusing products unless clients ask explicitly for it. Key Informant 4 has reused some doors for their own house but does not want to be involved with the certification process anymore, while Key Informant 9 indicates rarely using salvaged products, “between 5 to 10% of the time, probably less than that”.

Two Specific Uses of Salvaged Products
Despite the uncommon character of this activity, salvaged products are particularly reused in Dunedin for reparations in general, and in heritage buildings, as detailed below.

The Reuse of Building Products for Repairs
There seems to be a consensus across the respondents who discussed this point that, salvaged products are used for repairs and maintenance, as opposed to new building work (Key Informants 2; 5; 9; 12; 13; 14; 17). Storey and Keane (2008) have come to a similar conclusion as they have discovered that in New Zealand, this activity is confined to products used to repair and maintain households.

Key Informant 2, 9, and 11 explain that sometimes salvaged products are necessary to keep the building in harmony with its surroundings when repairs are required. They give, as examples, the use of similar tongue and groove floorboards and slates to replace the damaged ones. This use of salvaged building products to repair and keep an existing building ‘pleasing to the eye’ is considered by Storey and Keane (2008) as the most frequent in New Zealand.

In Dunedin, this activity is mainly adopted in old dwellings and heritage-type commercial buildings (Key Informants 2; 9). An anonymous building professional believes that salvaged products are hardly used in modern commercial buildings where retro-fittings are frequent, following depreciation factors. During the fieldwork, the researcher has been
unable to identify any example of a new building made out of salvaged products, unlike in Canada and in the United States of America, confirming that salvaged building products are used mainly for repairs and maintenance (Public Architecture, 2010).

**The Reuse of Building Products in Heritage Buildings**

Many old buildings and heritage buildings are present in Dunedin and there is a wish from the DCC and the community to preserve them (Dunedin City Council, 2007, 2009; Lloyd, 2005). Gorgolewski (2008) has found that reused products usually have an historic value. This finding is also valid in Dunedin, as there is a strong connection between the reuse of building products in Dunedin and heritage buildings (Key Informants 5; 10; 12; 13). Reusing building products from a heritage building subject to demolition to refurbish another heritage building is an option considered by many local key informants (Key Informant 3; 5; 10; 12; 13). Key Informants 12 and 13 notably salvage and reuse building products as much as possible for refurbishing their heritage buildings. Key Informant 5 believes that this activity in this type of buildings is relatively common to conserve a heritage character after renovation:

There’s a number that would just rip everything out and start all (over) again and there are others that would put a lot of care and effort into it, and (they) would be those people that tend to be reusing products. Others would just be looking for the cheapest, easiest option to refit their building… and it’s probably realistically, maybe it’s a 50-50 split at the moment.

**A Growing Awareness of Reusing Building Products**

Despite the exceptional character of reusing building products, there is undeniably a growing awareness of the value of this activity. Worldwide, since the twenty first century, the CIB has had a group researching on deconstruction to recover building products and on the efficient use of building products (Storey, Chini, and Schultmann, 2008). At the same time, the Vancouver Regional District has commissioned a guiding report to use when salvaging building products in new buildings (Kernan, 2002). In addition, a report from Public Architecture shows that some buildings are made out of salvaged building products in North America (2010). These research efforts on building product efficiency reflect the fact that material resource depletion is one of the top three priorities in the world on sustainable building (Storey, 2008).
This awareness on reusing building products also exists in New Zealand. Staff from the Victoria University carries out research on building product efficiency. One of them, Storey (2002), has notably studied the reuse of building products on-site to renovate a domestic building. In addition, all the key informants participating in this study were aware of this activity prior to being interviewed. Key Informants 15 and 17 refer to the greater amount of building product recovered from demolition/deconstruction as opposed to past practice to demonstrate its growing interest. Key Informant 5, although not a specialist on environmental issues, believes that it makes sense from an environmental and energy point of view to reduce the embodied energy of the building products and consequently reuse products. This respondent also considers that this situation is a long-term issue that society will have to face one day.

**Demand and Response**

Storey (2002) and Gorgolewski (2008) highlight the role of the client to commission the reuse of building products in their project. The same observation is made by the majority of key informants (Key Informant 4; 7; 9; 12; 13; 17). Key Informant 2 maintains that individuals rather than builders or building companies are more likely to reuse building products for refurbishment purposes. Key Informant 1 also indicates that usually building products are reused only if the client requires it.

The response from the building industry does not always match the demand from the public. Storey (2002) explains that contractors were not in favour of reusing building products in his Wellington case study. Of the architects and designers approached for this research, two different behaviours seem possible. Key Informant 4 does not wish to be involved in a reusable products project, explaining the difficulties in guaranteeing the structure and durability of these products. On the other hand, Key Informant 7, specialised in green architecture, works on such projects and advises clients to find building products as soon as possible. Builders are also involved and have different opinions regarding their involvement in the reuse of products: Key Informants 1 prefers using new products, whereas Key Informant 9 indicates sometimes undertaking the initiative to use salvaged products in restoration projects.

These opinions demonstrate that building professionals adopt a different approach to reuse of building products. Some of them participate in projects with salvaged products whereas
others prefer not to. Storey (2002) has found that although a contractor agrees to reuse building products, this professional can later require a shift to new products. This possible move to an easier process is also a common situation acknowledged by Gorgolewski and Morettin (2009).

5.1.3. A Multiplicity of Reusable Building Products

The information found in the literature on reusable products is basic as it does not detail the precautions to take into account prior to reuse. The interviews have allowed to fill this gap as the building industry is able to identify the challenges it faces when reusing each type of building products.

As Key Informant 7 emphasises, the range of recovered building products used depend on the variety of local resource available. Although Storey, et al. (2005) observe that most of the buildings in New Zealand are made out of timber, timber products are not the only reusable products in the country. A multitude of building products is reusable, according to the key informants interviewed, as presented below.

Stones

Key Informants 4, 7, and 10 quote stone as a reusable building product, as it is strong and does not ‘rot’ (Key Informant 4). These criteria used by Key Informant 4 are actually the criterion of durability used by Sunke and Schultmann (2009) in design for reuse. Key Informant 10 states that the NZHPT would encourage the salvaging and reuse of Port Chalmers breccia in the event of an application for the demolition of a building containing this material due to its rarity and its local source. These last two criteria are finding for this study as they are not mentioned in the literature consulted as decisive factors when selecting reusable building products.

Timber

Kernan (2002) observes that the products predominantly reused in Canada are those made out of timber products. They are beams, joists, trusses, doors, and decking materials. In New Zealand, all the key informants also quote timber as a reusable material. Furthermore, many of them advise salvaging native timber, such as kauri and rimu for their rarity and look (Key Informants 2; 4; 5; 12; 13).
However, some of these key informants mention the difficulties inherent to reuse of timber products. If it is used in the structure of a building, the timber treatment, its carrying load, and durability are questioned (Key Informants 2; 4; 12; 13; 14). For example, banisters can be reused if they comply with safety concerns (Key Informants 4; 5). The need to better know the quality of timber product prior to reuse is also an observation made by Kernan (2002).

Reusing timber for architectural purposes is easier than using it in the structure of a building. As a consequence, old timber beams can be used to give some character to a building if they do not carry any load (Key Informants 2; 12). Key Informant 2 also suggests that timber used in internal framing, cladding, and weatherboards can be reused as long as it is in a good condition and subject to its appropriate treatment. Figure 5.1 displays some timber recovered from the restoration of an old building in Dunedin, which could be used as architraves.

![Figure 5.1 - Example of Timber Recovered during the Restoration of a Building in Dunedin (Personal collection)](image)

**Joinery**

NAHBRC (1997) and Kernan (2002) agree that joinery, such as doors and windows, is easily reusable. This is also an observation made by many key informants (Key Informants 2; 4; 5; 12; 13; 14; 17). However, old windows might not always comply with the new regulations on windows in buildings (Key Informants 2; 4; 5; 9; 17). As Key Informant 5 explains, some people retro-fit double-glazing to some original windows to be able to reuse
them. Figure 5.2 illustrates some doors salvaged and sold at the Green Island landfill centre in Dunedin and Figure 5.3 presents some examples of doors reused in a Dunedin refurbished apartment.

![Figure 5.2 - Example of Doors Salvaged at a Dunedin Landfill (Personal collection)](image)

**Figure 5.2 - Example of Doors Salvaged at a Dunedin Landfill (Personal collection)**

![Figure 5.3 - Example of Joinery Reused in Dunedin (Personal collection)](image)

**Figure 5.3 - Example of Joinery Reused in Dunedin (Personal collection)**

**Floor**

Floor elements are considered reusable according to NAHBRC (1997). The salvaging and the reuse of floors sometimes occur in Dunedin. Key Informant 17 indicates salvaging carpets during demolition works and Key Informant 7 mentions having been involved in a
project where a whole floor made of floorboards has been reused. According to Key Informant 7, a precaution prior to reuse is to check that the joists used with the floor comply with the existing Building Code.

**Bricks**

Most of the interviewees consider that bricks can be reused (Key Informants 4; 5; 9; 10; 12; 13). However, some precautions need to be taken. Key Informant 12 affirms that some bricks are harder to recover than others, depending on the type of concrete used to bind them, which is confirmed by Nordby, et al. (2009). A cleaning operation has to be done prior to reusing them, which can make the cost of reusing salvaged bricks as high as the cost of using new bricks (Key Informants 9; 12). Another preventative measure consists in using the salvaged bricks according to their quality; internal bricks can not be reused externally as this exposes their frailties (Key Informant 10). Figure 5.4 illustrates the storage of stock-piled bricks. Mortar residues are visible in this photo.

![Figure 5.4 - Example of Bricks Recovered (Personal collection)](image)

The following types of building products are not quoted in the literature as reusable building products. However, they are reused in Dunedin.

**Steel and Other Metals**

Key Informants 12 and 14 agree that steel can be reused in structural purposes if it is certified. According to them, this material can also be used for architectural purposes. According to Key Informant 12, steel can have different qualities. It might need to be
coated with zinc to be protected from rusting, depending on the material and its use indoors or outdoors.

**Ceiling Tiles**
Key Informants 9, 12, and 17 declare that ceiling tiles are reusable, although they can be difficult to retrieve from a building. This practice is still happening as some of these tiles are valued on the market due to their rarity (Keys Informant 9; 12). Figure 5.5 illustrates some ceiling tiles recovered in Dunedin.

![Figure 5.5 - Example of Ceiling Tiles Recovered in Dunedin (Personal collection)](image)

**Roof Elements**
The recovery of roof-elements has been discussed by Key Informants 2, 9, and 10. Key Informant 2 refers to resource management issues involved in the reuse of products on the exterior of protected buildings. Products reused for these buildings may have to comply with the existing legislation, if the elements are not replaced like for like. The durability of products such as tiles has to be considered to avoid replacing them in the near future and incurring further costs (Key Informants 9; 10).

Many types of pre-used products have the opportunity to be employed in buildings. Other reusable building products not cited by key informants include gutters and rakes, piping and wiring and plumbing fixtures (NAHBRC, 1997). As highlighted for each type of product, some precautions are usually necessary prior to reusing them, particularly to ensure their durability and their compliance with the legislation.
**Unreusable Building Products**

A great number of building products can be reused but there are exceptions (Nordby, 2011; Schultmann, *et al.*, 2001). Academics and key informants identify many characteristics preventing a building product being reused. Some building products are inappropriate for reuse due to their condition and their poor quality (Gorgolewski, 2008; Key Informant 13). Key Informant 17 mentions products coming from a building that has been water-damaged, in which case nothing can be salvaged for a future reuse. Rotten timber, due to its condition, is also unsalvageable (Key Informants 1; 13).

Key Informant 10 and Gorgolewski (2008) declare that a building product can become obsolete because of the development of new technologies, a stricter regulation, or the health and safety risks it can incur. Key Informant 4 gives the case of windows which are not equipped with safety glass as an example of a non-reusable product whereas Key Informant 8, 17, and NAHBRC (1997) corroborate Gorgolewski’s statement with the example of contaminated products such as those containing asbestos or lead.

Key Informant 10 also affirms that a product has to be easily adaptable for its new purpose, in accordance with Paduart, *et al.* (2009). Key Informant 9 refers to a corrugated roof that can not be reused due to its nail holes, highlighting the need for appropriate use of connections between building products (te Dorsthorst and Kowalczyk, 2005).

The economic character of salvaged building products also gives weight to the decision to reuse it or not. Timber with too many nails incrusted can be too labour-intensive to be recovered and is consequently discarded (Kernan, 2002; Key Informants 1; 15).

**5.1.4. Reusing Building Products as a Labour Intensive Activity**

Reusing building products requires a series of activities to anticipate the supply, insure the quality of the products, integrate them into the building design, and install them, as detailed in the next sections.
Salvaging Products

Two Strategies

Two practices for salvaging products have been identified following the interview process. The first of the two options is to salvage products on a building site, as identified by Gorgolewski in his case studies (2008). Key Informant 17 acknowledges that the company employing this person hardly uses diggers but prefers instead to recover products by hand, sometimes recuperating 90% of products or more from the site. This rate of recovery is similar to the recovery rate of leading demolition companies from the North Island (Storey and Keane, 2008). The second option, not mentioned in the literature, consists of recovering the reusable building products sent to the landfill. A ‘man-pit’ is an employee in charge of this task (Key Informant 6). This interviewee affirms that the salvaged products are sold either in the recovery store on the landfill site or to a scrap metal merchant.

Demolition/Deconstruction

There are contradictory views on the recovery practice in Dunedin. Key Informant 5 believes that both demolition and deconstruction are happening in Dunedin whereas Key Informant 13 believes that few tradesmen recover products. One builder affirms that released building products, at the end of a building’s life, are usually landfilled unless they have an intrinsic value (Key Informant 1).

Overall, there seems to be a consensus with the key informants discussing this point that the only products salvaged are those with immediate monetary value. This approach is preferred by salvagers who consider the reusable value of the products on site (Key Informants 1; 2; 12; 13; 17). This practice is also depicted with what is called partial deconstruction in the literature (Guy, Shell, and Homsley, 2002).

Regarding demolition, Key Informant 17 highlights that the regulations demolition companies have to comply with, originate from the Department of Labour. They are supplemented by an on-going communication between this organisation and the company employing this informant. Key Informant 17 believes that the demolition activity could be better supported, given the dangers of the profession and the absence of training, to become more professional.
According to Key Informant 17, there is no policy or indication on the amount of product that could be recovered from a building under demolition. This lack of recovery rate in the legislation can be explained by the difficulty to enforce such requirement for every demolition, which depends on the condition of the building being pulled down (Key Informants 5; 17). The building might be in too bad a condition for any recovery to occur, and the recoverable building products can easily be damaged during this process (Key Informant 5). For example, tongue and groove floorboards are a building product sensitive to disassembly (Key Informant 10).

Storage
Storing salvaged building products is an optional phase when there is no immediate reuse to anticipate a future need (Gorgolewski, 2008; Key Informants 12; 13). In the literature, some unfortunate examples exist that relate the adverse effects of insufficient storage for building products that are sensitive to weather conditions (Storey, et al., 2005). These examples highlight the need for appropriate storage for some products, such as those made out of timber (Key Informant 12). Key Informant 13 also emphasises the need for the storage area to be close to where it is to be reused to reduce transport and optimise time-management.

Key informant 13 considers that in general the building industry is not well-equipped with salvage yards. Gorgolewski (2008) also suggests this fact when assuming a cost to store reusable building products. The space dedicated for storage influences the amount of salvaged products recovered and kept in reserve (Key Informants 1; 12; 13; Gorgolewski, 2008). Key Informant 12 shares some professional experience: “in the past we didn’t have much [space]. When I got this gas accumulator plate, I’d love to have lots, lots more, but I just didn’t have the room to store it. But now, we’ve got a lot more storage space and we’ve got lots in storage”. Indeed, the space required to store reusable building products can be significant. Key Informant 13 has lots of space dedicated for this purpose: “two containers full of products and one big storage area ... and in the building that I’m working on at the moment”.

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Obtaining Salvaged Products

Buying salvaged building products happens in non-traditional places and requires more effort than buying new (Key Informant 15; Mattu, 2008). The key informants interviewed have expressed many ways to obtain them. They all refer to salvage yards to get supplies of second-hand products, although they usually avoid shopping there because of the high price they charge (Key Informants 12; 13). This point is not perceived in the literature, as the cost of salvaged building products is generally perceived as lower than new products, without nevertheless being specific (Gorgolewski and Morettin, 2009).

In Dunedin, all the local key informants questioned on salvage yards are aware of the existence of two, and they all know of the biggest one (Key Informants 1; 2; 4; 5; 8; 9; 12; 13). Furthermore, Key Informant 9 affirms having shop occasionally in Christchurch salvage yards prior to the earthquakes, where the choice of salvaged products was higher than in Dunedin. The better choice of products in this city is confirmed by Key Informant 5 who explains that some Christchurch demolition companies sell building products they have salvaged from Dunedin in Christchurch.

An unexpected finding from the interview process is that the trading of salvaged building products becomes more common on the Internet. Key Informant 5 is informed that auction websites such as TradeMe compete with salvage yards. Key Informant 15 and an anonymous informant confirm that these websites are becoming increasingly popular. Indeed, they promote the salvaging of unwanted products, and sellers make a better profit than dealing with a salvage yard (Key Informant 5). The DCC is also adopting this approach with its support to the waste exchange website (Forsman, 2011). However, it is difficult to assess the amount of transactions happening given the nature of e-trading (Key Informant 14).

Other ways of obtaining salvaged building products exist for owners by recovering the products from their own buildings (Gorgolewski, 2008; Key Informants 12; 13). In addition, some building products can be given away. Key Informant 12 explains sometimes being contacted, by friends and acquaintances to pick up some recoverable building products for free.
Certification

Many key Informants and Kernan (2002) highlight the need to be aware of the properties of the salvaged products, such as their strength, carrying capacity and treatment, if they are to be used for structural purposes (Key Informants 4; 5; 14). This is possible with the certification of building products. Key Informant 2 indicates that it is imperative to get someone certifying the properties of these products if they are to be used in the structure of a building:

If they want to use recycled stuff… you need an engineer to sign off the structure and the durability of it… They have to be on the New Zealand register of IPENZ… If someone goes ahead and uses recycled timber without using the appropriate timber, then they have done a building without building consent and they’ll get fined for that.

Although at first sight, the process to get a building with salvaged products used in the structure certified seems straight-forward, Key Informant 4 indicates the difficulties to find a certifier: “it comes down to who wants to put their name on the line as to certifying these products… And most people are shying away from it because they just don’t want to be involved, that’s the problem”. This statement confirms the finding of Kibert and Chini (2000) and of Storey and Keane (2008) that the certification of salvaged products is uncommon and almost impossible.

The availability of information on products’ quality is supposed to help identify their properties and therefore help the certifier (Kibert, 2008). Key Informant 7 suggests the labelling of salvaged building products when they are retrieved from a building which is going to be demolished or deconstructed, as does Gorgolewski (2008).

Design

Key Informant 7 believes that reusing products has to be integrated into the design of the building to decrease the problems it can generate. This opinion is also supported by Storey (2002) and Kernan (2002) to get a harmonious building design. Key Informant 7, as an architect, advises clients wanting to reuse building products to obtain them early in the process to incorporate them into the design. For this building professional, design consists of finding solutions to issues. So in the event that reused windows are single-glazed, they are sealed, and some criteria such as their location towards the North, mitigate the negative effects of these building products.
Design with salvaged products is considered time-consuming and labour-intensive in the literature as it adds complexity to traditional designs (Storey, 2002; Gorgolewski and Morettin, 2009). This labour-intensive work is confirmed by Key Informants 4 and 7. However, Key Informant 7 puts this fact into perspective as this architect assures that obtaining salvaged products prior to design helps decrease the workload, even if it remains more demanding than adopting a traditional approach.

**Preparation of Salvaged Products for Reuse**

The reuse of building products is more labour-intensive than the use of new products, particularly in the design and preparation phases prior to reuse (Gorgolewski, 2008). Salvaged products are selected and sorted out for reuse (Key Informant 12; Storey, 2002). Many of the key informants consider the time they will spend to prepare salvaged products before they decide whether to reuse them (Key Informants 12; 13; 15). For example, tasks include cleaning bricks and shortening pieces of timber so that they fit their new purpose (Key Informants 12; 13). Key Informant 13 particularly illustrates the labour required to prepare salvaged timber by explaining that it necessitates denailing and pre-drilling prior to nailing so that it does not split. In addition, this labour sometimes requires skills that the building industry is not practising frequently anymore, as Kernan observes in Canada, with the example of the construction of windows by builders (2002).

**The Alternatives to the Reuse of Building Products**

The alternatives to the reuse of products considered to compete with this activity are detailed in this section. These alternatives can offer a different use for C&D waste other than being reused in building. This is for example the reuse of building products for a purpose different than for building, recycling, or discarding building products. The alternatives can also suggest the use of other products rather than salvaged ones in building, e.g. the use of new products.

**Reuse for a Purpose Different from Building**

This reuse for a purpose different from building is not analysed in the literature. Although not presented in C&D waste management and minimisation strategies, C&D waste can be valued in sectors other than building. Key Informant 8 suggests that even if salvaged building products do not fit in a building, they can be reused for a different purpose, where their quality and durability do not matter as much. Salvaged building products can be transformed in art pieces (Key Informant 12). The timber recovered from buildings is
usually used for furniture-making (Key Informants 2; 12; 17). Concrete and bricks are used as cleanfill to cap landfills and rubble is currently used to reclaim land in Lyttelton (Key Informants 5; 6). Another profitable use for rubble consists in employing it to protect land against sea-level rise (Key Informant 8).

**Recycling**

An alternative to the reuse of building products is their recycling. The literature considers that this option is sometimes a type of reuse (Paduart, et al., 2009). The C&D waste ladders developed by the Dutch do not differentiate between C&D waste management and minimisation strategies, whereas some of the interviewees do (Janssen and Hendriks, 2002; Key Informants 8; 14). Key Informant 8 and 14 acknowledge that recycling is not as environmentally-friendly as reusing products. Key Informant 8 presents the value of reusing over recycling: “recycling, it’s pretty good, it’s better than throwing it in the landfill but it’s just one step up really. You’re much better to reuse… because it takes energy to recycle a material”.

**Discarding Building Products**

Key Informant 12, 13, and 17 explain that burning salvaged wood is common in the building and salvage industry. The less environmental option is to landfill the building waste, when it has no more value, as depicted in the Lansink’s and Delft’s Ladders (Janssen and Hendriks, 2002). The landfilling of building products also usually happens following the demolition of a building, a poor environmental option to pull down a building (Hobbs and Hurley, 2001; Key Informant 13).

**Using New Building Products**

All the key informants acknowledge that it is easier to use new products than reusing them in any building project. This is confirmed in the literature by Gorgolewski and Morettin (2009). Key Informant 1 and 15 indicate that buying new products is time-efficient. This is true if the amount of time to find the salvaged products and their cleaning process is considered (Key Informants 1; 9; 12; 13; 15). Key Informant 1 also mentions the cost-effectiveness and the standardisation of new products facilitating the job. This interviewee also refers to the assurance that the timber is treated when bought new.
Summary section 5.1: the reuse of building products is a traditional activity that has become uncommon in the past thirty years, although there are some rare exceptions. This activity is uncommon in New Zealand for new build but niches of reuses are found for repair and maintaining of heritage buildings. There is a multiplicity of building products that are reusable, and their quality has to be assessed prior to reuse in the structure of a building. Generally, reusing building products is a more demanding activity than traditional practice requiring lots of precaution and anticipation. This is why alternatives to this activity, usually easier, are preferred by society.

5.2. Sectors Relevant to the Reuse of Building Products
When tackled by international building research organisations, such as the CIB, the reuse of products is treated as a side component within the topics of solid waste management, and sustainable building. These sectors are also found to be relevant to this activity by the interviewees. Moreover, the data provided by the key informants has highlighted the link between the reuse of building products and heritage preservation. These connections between the reuse of building products and these sectors are detailed in the following sections.

5.2.1. Construction and Demolition Waste Management
The Reuse of Building Products as a Construction and Demolition Waste Management and Minimisation Option
C&D waste hierarchies have been developed to list waste management and minimisation options, such as the Lansink’s, the Delft’s and the Eindhoven’s Ladder. These schemes acknowledge the reuse of building products as one of the waste management and minimisation strategies. In Lansink’s Ladder, this activity is rated as the third best environmental waste management option (Janssen and Hendriks, 2002). In New Zealand, the Waste Minimisation Act 2008 reflects this ranking of the best environmental waste management and minimisation options, and also recognises the reuse of waste as an option (section (5) of the Waste Minimisation Act 2008). Key Informant 8 and 14 are the only interviewees that acknowledge the ranking of environmental waste management and minimisation options.
Significance of Construction and Demolition Waste
The significance of the C&D waste stream in total waste production is acknowledged at different levels. At an international level, it is said to amount for between 40 and 50% of the total waste production (Storey, 2008). The situation is similar in New Zealand, where the C&D waste stream is estimated to account for up to 50% of the amount of waste generated (Ministry for the Environment, 2010a). According to Key Informant 6, these statistics are similar in Dunedin.

Despite its significance in volume, C&D waste is not considered as a priority in waste management. According to Storey and Keane (2008), the emphasis in C&D waste in New Zealand is on landfill space, and not enough on resource conservation. This statement means that C&D waste is not considered as a useful resource but as a definitive waste. The New Zealand legislation reflects this lack of awareness on the significance on C&D waste, by not insisting on it (Waste Minimisation Act, 2008, Ministry for the Environment, 2010b). Key Informant 6 agrees with the fact that the C&D waste stream is not a priority in Dunedin because the DCC can not control this waste stream and because of the lack of political support for it, as opposed to kerbside recycling.

Insufficient Construction and Demolition Waste Monitoring
Academics highlight some inefficiencies in accounting for C&D waste worldwide, with many underperformances easily solvable. In New Zealand, there are some uncertainties on the statistics on C&D waste due to a lack of consistent monitoring as it is difficult to obtain data from cleanfills (Ministry for the Environment, 2011c). Key Informant 6 reports the same situation in Dunedin, where some C&D waste is landfilled in places which are not registered landfills.

Unreliable data on C&D waste prevents its significance to be acknowledged (Yost and Halstead, 1996). As Hobbs (2011b) emphasises, better information on C&D waste is indispensable in order to know more about it and to organise coherent management and minimisation strategies. Key Informant 6 acknowledges that C&D waste should be a priority because of its significance. However, this person highlights the difficulties in monitoring this waste stream, as opposed to household waste which is collected by the DCC or its contractor.
Despite this difficulty, the DCC is currently working with the building industry to better monitor C&D waste production and treatment in Dunedin (Key Informant 6). The DCC is at the early stages of its agenda on local solid waste management and is waiting to get a more accurate overview of its solid waste production, in quality and quantity, to adopt a waste minimisation programme relevant to the local needs (Key Informant 6). This person also acknowledges that reporting the amount of demolition waste from a building is an option that they are considering but they are waiting to be at the second stage of their waste schedule. Therefore, there are opportunities for the DCC to consider the reuse of building products as a waste management and minimisation strategy later on in their planning process if it appears that a significant volume of C&D waste is produced in Dunedin.

5.2.2. Sustainable Building

Definition and Perceptions of Sustainable Building

The scope of sustainable building is broad as it seeks to reduce the environmental effects of buildings while taking into account the ecological, social, cultural and economic components of a building project (Kibert, 2007). As established in Chapter Two, reusing building products is a strategy to get a more sustainable building as it provides environmental, social, cultural, and economic outcomes (Gorgolewski, 2008; Gorgolewski and Morettin, 2009; Storey, et al., 2003).

Authors and countries usually focus on a selection of key areas to make their built environment more sustainable (Kibert, 2008). The definitions of sustainable building by key informants reflect this preference to focus on a limited number of criteria. The interviewees are usually broad in their consideration of sustainable building and their views reflect the complexity of defining this topic. The opinions of the key informants on sustainable building are listed in the following table, Table 5.1:
Table 5.1 - Components Used by Some Key Informants to Define Sustainable Building

<table>
<thead>
<tr>
<th>Components defining sustainable building</th>
<th>Key Informant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw-bale house and mud brick house</td>
<td>Key Informant 2</td>
</tr>
<tr>
<td>Energy-efficiency of the building</td>
<td></td>
</tr>
<tr>
<td>Make the house more liveable</td>
<td>Key Informant 4</td>
</tr>
<tr>
<td>Durability of the components</td>
<td></td>
</tr>
<tr>
<td>Example of the passive design of old buildings</td>
<td>Key Informant 5</td>
</tr>
<tr>
<td>Reuse of old buildings</td>
<td></td>
</tr>
<tr>
<td>Include the building within its environment</td>
<td>Key Informant 7</td>
</tr>
<tr>
<td>Passive and active design</td>
<td></td>
</tr>
<tr>
<td>Local products</td>
<td>Key Informant 8</td>
</tr>
<tr>
<td>Renovation of an existing building</td>
<td></td>
</tr>
<tr>
<td>Smallest space consumed</td>
<td></td>
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<tr>
<td>Reduces environmental footprint</td>
<td></td>
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<tr>
<td>Timber houses as a sequestration of carbon</td>
<td></td>
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<tr>
<td>Common-sense construction</td>
<td>Key Informant 9</td>
</tr>
<tr>
<td>Efficient use of products</td>
<td></td>
</tr>
<tr>
<td>Source of products (not wood from rainforest)</td>
<td></td>
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<tr>
<td>Passive design</td>
<td></td>
</tr>
<tr>
<td>Marketing strategy</td>
<td></td>
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<tr>
<td>Economically-sustainable</td>
<td>Key Informant 14</td>
</tr>
<tr>
<td>Sympathetic to the environment</td>
<td></td>
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<tr>
<td>It has to deliver to people</td>
<td></td>
</tr>
</tbody>
</table>

Some of the criteria expressed by the key informants that define sustainable building are coherent with the use of salvaged products in building projects. This activity is a method to achieve a sustainable building and have a more liveable house. It can be adopted to renovate an existing building and to reduce the building’s environmental footprint. With it, the supply of local products is possible. It is a common-sense construction as it avoids waste production and it is an efficient use of building products. It also meets the criteria expressed by Key Informant 14.

Although common outcomes can be found for sustainable building and the reuse of building products, the answers from the Dunedin building industry, in Table 5.1, reflect the large scope of sustainable building as specified by Kibert (2007). These answers also reveal that the Dunedin building industry does not perceive a causal link between sustainable building practices in New Zealand and the reuse of building products (Key Informant 1; 4; 5; 7; 8; 9).
A Limited Demand for Sustainable Buildings in Dunedin

Worldwide, there is an increasing awareness of the concept of sustainable building, with the development and implementation of green building rating tools, according to the national reports in the W115’s 2011 publication. The NZGBC and other New Zealand organisations, as detailed in Chapter Four, follow the international trend to promote green buildings in New Zealand. This awareness of the concept of sustainable building is also found in New Zealand through the existence of two green building rating tools: one dedicated to non-residential buildings: the Green Star, and one for residential buildings: the Homestar.

Despite this promotion of sustainable building, all the key informants perceive that good practice is still the exception in New Zealand. According to a private correspondence with the NZGBC, there were 48 Green Star rated buildings in July 2011. Several key informants indicate that there is a limited demand for sustainability in the building industry. Key Informants 4, 7, 8, 9, and 14 consider that few buildings are built in a sustainable way in Dunedin. Key informant 9 explains that few clients are commissioning sustainable building: “I’ve heard of over the last ten years of one client that was going pretty sustainable and that was pretty hard core sustainable. But that’s only one”. Key Informant 4 has a similar experience, having few demands for sustainable buildings. Unlike these testimonies, Key Informant 7 declares working in sustainable building projects, but only for some niches of clients:

We’ve always done projects which are associated with wildlife. We’re entirely practised, that’s been our lot. So we have been involved with different wildlife species like albatross, penguins, Kakapo, Takihi, Kiwi, few others. We’ve always been in that arena anyway; where their habitat is very important... We, in this practice, for some reason or another, seem to collect academics as clients who are probably more thoughtful than most people about these things which they find important. We’re also lucky that we’ve done some work for university, on different buildings down there. And that pushed the envelope a wee bit. We started years ago in the psychology department... So since we did that, we have had a bunch of psychologists and psychiatrists and other that have been our clients.

This information suggests that, currently, promoting the reuse of building products through the concept of sustainable building may have a limited impact in New Zealand and in Dunedin, unless sustainable building becomes popular.
Comparison with Overseas

When asked to rate the sustainability of New Zealand buildings in comparison to overseas buildings, many key informants are unable to provide any answer (Key Informants 2; 9; 14). However, most of the interviewees tend to put their answer into perspective by mentioning good and bad practice in any country, even the leading ones. As Key Informant 7 explained: “I’m not sure that the comparison is valid. The resource we’ve got is here. We should be using it better. There’s no point comparing it with Italy or Scandinavia where their resource is different”.

5.2.3. The Heritage of Building Products

The Preservation of Townscape when Reusing Building Products

The Dunedin City District Plan emphasises the role played by heritage buildings in the townscape of the city (Dunedin City Council, 2006). A few informants identify the reuse of products in buildings as an activity that have the potential to impact on townscape and streetscapes (Key Informants 3; 4; 5). As Key Informant 3 explains, some rules in the Dunedin City District Plan are designed to maintain the character of some townscape and heritage precincts, and the nature of buildings scheduled in this planning document. This interviewee indicates that there is no inconvenience in using a similar product to the original one for replacing a building component which is visible from the street. However, this person highlights the need to apply for a resource consent to use a product which will give a new look to the building to ensure it is embedded harmoniously within its environment:

For example, you can replace a roof on a heritage building provided that you use products that are like for like. For example, if you have a slate roof, and you’re going to change it into a decramastic tile roof or something like that, then you actually trigger the need for a resource consent (Key Informant 3).

This statement shows that reusing building products in a like for like manner is encouraged by the local planning legislation.

The Potential Heritage Loss Resulting of the Demolition of Heritage Buildings

Key Informants 5 and 10 mention the demolition of some heritage buildings in Dunedin. Currently, an average of two to three heritage buildings a year are demolished in the area comprising of Otago and Southland (Key Informant 10). According to the heritage
industry, some heritage building owners are investigating the process of getting their property demolished, potentially having an impact on the recovery and salvation of building products (Key Informants 5; 10).

Economic reasons are usually put forward when enquiring about the process to get a heritage building pulled down (Loughrey, 2011). The recent economic climate is a challenge for the owners of earthquake-prone buildings in Dunedin (and also in New Zealand) following the Christchurch earthquakes, as insurance companies have increased their fees for earthquake-prone buildings (Key Informant 5). Additionally, the revision of the *Dunedin City Council Dangerous, Insanitary and Earthquake-prone Buildings Policy* worries some owners over the cost of strengthening their building to make them comply with this draft legislation. The local environment is also difficult given that many Dunedin heritage buildings remain unoccupied or given that their lease or rent is low (Key Informant 5; Loughrey, 2011). Cost of maintenance can be hard to recover in these conditions. Consequently, a redevelopment of the site becomes attractive to some landowners with an eye on their return on investment (Key Informant 5).

**The Heritage Character of Some Salvaged Building Products**

The heritage character of building products released from heritage buildings is identified as significant by some stakeholders and by Gorgolewski in the literature (2008). As Key Informants 10 and 13 emphasise, salvaged products released from heritage buildings tell the story of the building, and show the age of the building. Key Informant 10 enlightens on the fact that reusing products on-site is telling the story of the site, keeping a “continuum on the site of historic interpretation”. This informant gives several reasons to value heritage products: their history, the technique used to produce and use them, their standard of finish, and their rarity.

Key Informant 10 advises that it is ideal to obtain the story behind the building product to get the ‘knowledge’ of its origin. This person recommends using salvaged products with consideration in order for people to not confuse the heritage building products added to the original products and mix styles: “the only thing you have to be concerned about is making sure you don’t confuse things by introducing something which is not relevant to a significant building”. Such detailed findings on the heritage value of salvaged building products have not been found in the literature consulted.
Summary of section 5.2: three sectors are found relevant to the reuse of building products: C&D waste, sustainable building, and the heritage of building products. C&D waste is currently not a priority for the government neither in New Zealand nor in Dunedin. Waste is usually still considered as a landfill space issue and insufficient as a resource loss, although opinions are evolving. C&D waste monitoring is still insufficient, although processes are in place to get a more accurate overview. The reuse of building products is also conforming to the philosophy of sustainable building. However, it is a recent and broad concept, with a limited application in Dunedin, and more generally in New Zealand. The third sector relevant to the reuse of building products is the preservation of heritage building products. Some key informants have identified the benefit of this activity to preserve the townscape of Dunedin, and heritage in general as a second protection measure when a heritage building cannot be preserved as a whole.

5.3. Summary

The first research question seeks to provide an overview of the reuse of building products in New Zealand and Dunedin. Consistent with international literature, the reuse of building products in New Zealand is not well-documented. It is indeed difficult to assess to what extent this activity is occurring, both in New Zealand and in Dunedin. However, the findings from the interview process have proved that this activity is occurring in Dunedin even if it has an exceptional character. In Dunedin, salvaged products are used mainly to repair and maintain existing and historic buildings, but not to make new buildings. This observation suggests that reusing building products can be encouraged for reparations and for heritage buildings and that using salvaged products in new build should be investigated in New Zealand.

The interviews have also shown that some local building professionals have the ability and the desire to salvage and reuse building products, although some negative factors are found to affect a wide reuse of building products. On the whole, this activity necessitates a labour-intensive work prior to being able to carry it out, and sufficient space is needed when storing salvaged products. Another significant point is that the reuse of building products is identified as both a C&D waste management and minimisation strategy and as a sustainable building strategy. Yet, these sectors are not widely supported in Dunedin and New Zealand, although society is increasingly becoming aware of them.
6. Barriers Against and Opportunities for the Effective Reuse of Building Products

Objective Two seeks to identify the barriers against and the opportunities for the effective use of products recovered in the Dunedin building industry. The positive and negative factors influencing this activity are analysed from the collected data following the literature review and the examination of the interviews. They are classified through five main themes: research, education, economy, legislation, and leadership. The analysis of these factors helps uncover opportunities for each of these themes. Objective Two ‘to identify the barriers against and the opportunities for the effective reuse of products in the Dunedin building industry’ is addressed in this chapter.

Therefore section 6.1 presents an overview of the issues associated with the reuse of building products and of the opportunities suggested. Section 6.2 refers to the research efforts on the reuse of building products. Section 6.3 discusses the factors affecting the education of the building industry and more generally of society. Section 6.4 examines the economic factors of reusing building products. Section 6.5 presents and analyses the information relative to legislation. Section 6.6 suggests the stakeholders who could take a leadership role in encouraging the reuse of building products and section 6.7 concludes this chapter.

6.1. Projection on the Future

The key informants discussing the future of the reuse of building products have a mixed opinion on it. Key Informant 2 does not imagine new buildings integrating salvaged products. This is corroborated by Key Informant 13 who believes that the younger generation prefers consumerism and the use of new products rather than recovering them. Contrary to this, Key Informants 9 and 12 are more optimistic, and forecast some demand for renovation which gives an appearance of character to a building. Key Informant 12 even believes that the demand will increase.
Generally, all informants are unsure of the push necessary to support the reuse of building as it is a commercial activity (Key Informants 5; 10; 11; 13; 14; 15). Therefore, they identify the supply and demand for this activity as a significant factor promoting it, but some of them regard it as a chicken and egg situation (Key Informants 10; 11; 14). Skilled professionals able to reuse products might generate a demand. However, this demand has to be sufficient enough to maintain this industry. To develop this market, the barriers identified in this research need to be taken down. Therefore, research needs to complement the education process to make this activity more efficient. Society has to be educated on the benefits of reusing building products. Government needs to revise its economic incentives to favour salvaged products. Legislation has to be altered to develop a framework for this activity and be more favourable to it. Consequently, leadership has to be adopted at different levels.

6.2. Research

6.2.1. International Research

There is awareness among the academic world on the recovery of building products, notably with research on design for reuse and deconstruction (Paduart, et al., 2009; Saleh and Chini, 2009). This is mainly organised by the CIB, through its previous group TG39 and its current commission W115. The role of this last unit is to find more on this topic and raise awareness on this issue by making this knowledge available (Storey, Chini, and Schultmann, 2008). Storey and his colleagues from Victoria University have, in particular, been a hub between the CIB and New Zealand, learning good practice from other countries, and raising awareness on the efficient use of building products in the New Zealand building industry, particularly through their teaching.

Despite these positive factors, progress is still possible. International research in North America demonstrates that salvaged building products can be reused in new buildings (Public Architecture, 2010). An opportunity for New Zealand researchers is to investigate and adapt it to the New Zealand context. There is also a gap in the recent international literature on design with salvaged building products. Information is notably missing on the precautions to adopt prior to reuse, on the technical difficulties for builders, on the easiest building products to reuse, and on the legal framework to carry out this activity. There is an opportunity for researchers from W115 to study and fill in these gaps, and offer a
complete document to assist designers and architects to integrate salvaged products into building projects.

Furthermore, Key Informant 14 explains that currently nobody accounts for the externalities to calculate the price to a building product. Taking into account all the costs associated with new material, such as its greenhouse gas emissions or the necessary treatment of residual pollution into the environment, could alter its competitiveness on the market (Berge and Henley, 2000). Research could be undertaken to discover the total cost of new building products so that their regular consumption is discussed.

6.2.2. National Research

Research done by educational and research organisations such as universities and polytechnics plays a significant role in the promotion of more sustainability in buildings. The Sustainable Habitat Challenge, consisting of building or renovating a building with sustainable criteria such as reusing building products, demonstrates that there are possibilities in carrying out this activity (Sustainable Habitat Challenge, 2008). It presents good practice to the building community, educates the new generation of building professionals to sustainable practice, and calls for innovation. This programme also demonstrates that generally, there are opportunities to integrate the reuse of building products as a topic of research in many sustainable building research programmes.

Despite this good practice, generally, the numerous research organisations relevant to the reuse of building products hardly cover this topic. Opportunities are there for them to integrate it into their research programmes. Research organised by BRANZ, notably through the programme REBRI, refers to this activity as good practice but misses out information for guiding designers on the process to follow and on the relevant legislative framework (Building Research Association of New Zealand, 2005). Filling these gaps and demonstrating further examples of good practice, with practical solutions could help with a preference to use salvaged products over the use of new ones. In addition, under the BRANZ programmes, researchers have the opportunity to better investigate the technical requirements associated with the use of salvaged products, establish a list of the building products that can easily be reused, and develop criteria to maximise their recovery and reuse.
The NZGBC, research and rating of sustainable buildings, has a criterion on the reuse of timber products in its green building rating tool. This organisation has the potential to broaden the scope of their Greenstar programme by giving credits for the reuse of other building products than just timber products.

WasteMinz and the Zero Waste New Zealand Trust are organisations advocating on waste reduction. They have the potential to research on C&D waste management, consider the reuse of building products as an option, and assess the amount of waste recoverable with this method.

A few of the interviewees believe that the leadership should come from research organisations (Key Informants 5; 8). Key Informant 5 considers that independent organisations, because of their neutral attitude, should adopt a research programme on the reuse of building products. This respondent believes that BRANZ or the NZHPT could be involved in this type of project and test some products. This person is also favourable to the involvement of universities to create data and provide more certainty when reusing salvaged products. Key Informant 8 is also sympathetic to research encouraging innovation, like the Sustainable Habitat Challenge: “it allows us to experiment. At least, we’re able to experiment and play around and make mistakes, we can’t really make any progress, can we if we’re just sticking to what’s allowed? Then we don’t make progress”.

These key informants’ comments suggest that national research organisations share their findings with the affected stakeholders. From a national perspective, many research organisations have an educative approach. The REBRI programme is currently researching on the residual life of building products and one of its researchers is particularly involved with the heritage department of the DCC (Key Informant 5). This co-operation between research organisations and local governments ensures that results of research are passed on to the community. BRANZ has adopted the same attitude, researching and delivering its findings to the building community (Key Informants 4; 9; 16).

**Summary of section 6.2:** there are some barriers in research for a greater reuse of building products. Research on this activity is very limited. Information is notably missing on good practice to integrate salvaged products in building projects. Moreover, the real cost of new building products is unknown. However, some positive points are identified. The positive factors are that research organisations can include the study on this activity in their
programme. Furthermore, this research is worthwhile as these organisations usually make their findings available to the stakeholders. Therefore, the opportunity for them is to expand their programme to include the reuse of building products as an activity worth considering.

### 6.3. Education

All possible stakeholders should be aware of the benefits of reusing building products to encourage it and adopt it. The building industry is one of the main stakeholders who have to be convinced and educated on the values and know-how of the reuse of building products in order to carry it out. Society in general, is not always sensitive to its benefits to require it to be better applied. The next sections discuss the prejudices that need to be overcome in order to favour the reuse of building products by these two groups of stakeholders.

#### 6.3.1. The Building Industry

The building industry perceives difficulties in reusing building products (Gorgolewski and Morettin, 2009; Key Informants 1; 2; 4; 5; 9; 12; 13; 14; 15). Uncertainties on the quality of the products, the cost and delays resulting in this activity, and the hostile legislation dampen the enthusiasm of stakeholders who could be favourable to this activity (Hendricks and Janssen, 2004; Key Informants 1; 4; 5; 12; 13; 14). The building industry is also characterised by a lack of awareness and a lack of willingness to be more environmentally-friendly (Bio Intelligence Service, 2011).

### The Traditional Mindset of the Building Industry

The building industry is considered too inflexible, preventing innovation to happen and the adoption of environmental practices. King and King (2005) indicate the traditional mindset of the building community as a hindrance to a revolution in the industry. Storey (2002) emphasise a lack of interest by contractors for environmental solutions if they require a change in traditional practices. Key Informant 4, 9, and 14 agree that the building industry is relatively traditional. Key Informant 4 expresses that: “they [builders] all think that builders are guys that are good with a saw, a hammer and nails, know how to order the products up and stand the frames up... It’s a mentality thing”. This statement suggests that builders are focussed on their physical work only and miss considering the impacts of their activity.
This traditional mindset is visible on building sites through the absence of specific C&D waste management (Key Informant 9). However, Key Informant 9 minimises the responsibility of builders by attributing this fact to the lack of space necessary for sorting out the C&D waste on building sites, the lack of education of builders on these practices, and the lack of market for this waste. Key Informant 8 comments that traditional building practice exists because people usually copy the wasteful misbehaviour they see happening, and consequently throw everything into the tip without sorting out their waste.

On the other hand, only one informant, Key Informant 14, is more neutral towards this perception: “the New Zealand building industry is like most industries, it’s relatively conservative. It’s got to be a good reason, a very clear reason for change, relatively well-tried, and sort of robust alternative. You stick with what works”. This comment is more balanced and suggests that presenting well-argued alternatives to traditional practice could result in a shift in their approach to building.

The Choice for Builders to Be Trained
Currently a builder does not need any certificate or training to auto-proclaim to be a professional, resulting in some New Zealand builders being unqualified (Key Informants 9; 15). Key Informant 1 has chosen to never attend building seminars to update his skills or to be informed on new building practices. One reason put forward by most the interviewees is that the building industry is embedded in a trading environment where investments are frequent and economic performance a daily concern, meaning that builders do not want to waste time attending building seminars that they do not value (Key Informants 1; 4; 5; 12; 13; 14). Seminars and workshops delivered to the building industry also do not seem to meet the expectations of this community. Key Informant 9 rates some of them with an unfavourable time spent/knowledge ratio, and doubts the necessity to attend all of them. This person gives the example of a seminar on batts, judged pointless as this respondent believes that the only information builders need to know about them, is their installation.

Training sessions currently seem to be attended more by managers than workers. As Key Informant 9 mentions: “there always could be more training but a lot of times, guys just want to do the job. Guys like me, in a management position have to train and all that, but the general workers, they just need to do their own job”. Despite the builders’ lack of interest for updating their skills, also confirmed by Key Informant 4, Key Informant 15
acknowledges that usually these professionals do not undertake a task that they do not fully understand. This situation is nevertheless evolving given that builders who work on restricted building work have to be licensed by March 2012 to be able to keep on doing their activity (Key Informants 9; 14).

**A More Knowledgeable Industry**

An evolution in the tasks of builders is acknowledged by Key Informants 4, 9, and 15 as builders have to be able to read plans and do the building work in accordance with their specifications. As Key Informant 9 explains, the training of builders has evolved:

> When I first started as an apprentice, you just turned up and then you worked. Now it’s becoming… You know, you’ve got a trade, an apprentice-based scheme and you’ve got a varsity degree. I think it’s coming in between those. You have to know more and more and more, especially when you run a company. The products are becoming trickier. There’s more choice. You’ve got to learn so much more.

Some organisations within the building industry have developed an educative approach to make it more efficient. The BCITO encourages best practice on a building site (Key Informant 15). It is favourable to innovation in building and has developed a chapter dedicated to non-traditional building practices in their book that accompanies the training of their apprentices (Key Informant 15). The University of Otago and the Otago Polytechnic are sensitive to sustainable building with the University campus master plan, sustainable design courses, the sustainable habitat challenge, and the business for change group.

The Architectural Designers New Zealand Institute gathers designers and architects, who must update their professional knowledge with compulsory professional development (Key Informant 4). BRANZ organises seminars and publishes magazines to inform the building community on good practice which are accountable to the Licensed Building Practitioners scheme (Key Informant 16). Building stores also participate in the education process by organising meetings for builders (Key Informant 9; 15). The building industry also gathers Master Builders and Certified Builders, which are groups of builders subscribing to a voluntary licensing programme. They provide information on diverse topics, including contract design and on insurances (Key Informant 9). The builders affiliated to these organisations receive invitations to local seminars and building publications (Key Informants 9).
In addition, a Licensed Building Practitioners scheme will be mandatory by March 2012 for building professionals involved in restricted building work (Key Informant 14). Key Informant 9 and 14 indicate that the goal is to upskill the industry, professionalise it over the years, and restrict the builders who are untrained or lack theoretical experience. To remain licensed, building practitioners have to obtain a certain amount of on-going professional development points per year, depending on their category (Key Informants 9; 14). A view from the industry compares this system to an ‘on-going school maintenance’ programme. The Department of Building and Industry, while not organising the conferences for builders, keeps track of the programmes attended and the amount of points accumulated by the licensed building professionals (Key Informant 14). The positive outcome of this system is that building professionals become educated to perform their tasks efficiently.

**Providing Guidance to Reuse Building Products**

Despite the involvement of the organisations listed in the previous paragraph to upskill the building industry, there is limited information available on reusing building products in New Zealand, closed materials loop and deconstruction (Key Informants 4; 17; Storey and Keane, 2008). The lack of information on the reuse of building products is particularly missing for designers as well as training for the demolition industry on deconstruction (Key Informants 4; 17; Public Architecture, 2010).

All the organisations educating building professionals have the opportunity to develop a coherent programme to make the building community understand the value of reusing building products. These organisations can help the building industry be efficient in, commission, organise, and carry out this activity. As Key Informant 1 thinks, having directions to “use old jara beams” in plans from architects and designers will guide building professionals in adopting this activity. Organisations training future building professionals, like Universities, Polytechnics, and BCITO have the opportunity to educate their students who are the future building professionals. Besides, the best option for active building professionals might be to offer guidance for the reuse of building products in seminars or documentation, which then would count for the mandatory character of their on-going professional development.
In addition to seminars and workshops, Key Informants 4 and 15 emphasise that a leaflet is necessary for professionals to know the products they are able to reuse, according to the legislation. There is an opportunity for educational organisations to release easily accessible information on the internet, given its popularity, and through publications on the reuse of building products for each body of building professionals. Key Informant 4 advises listing the products in categories according to their durability, their use indoors or outdoors and the type of building they are used for.

**Establishing an Educational Centre for Professionals Specialised on Heritage Buildings in Dunedin**

Another opportunity exists in developing an educational centre for building professionals dedicated to the restoration of heritage buildings in Dunedin (Key Informant 5). Key Informant 12 and 14 agree with the need for education to train builders or craftsmen to reuse building products, especially heritage products. An anonymous key informant believes that this scheme could be part of a bigger picture to preserve heritage and include a marketing scheme to generate a demand for this activity. These craftsmen need to be skilled to successfully perform the restoration and maintenance of heritage buildings and therefore need to find an appropriate place to be educated. Key Informant 5 explains that this centre would create some jobs in Dunedin given that restoration and reuse are more labour-intensive than building new. This respondent emphasises that the population would not oppose this project as it allows jobs creation.

Key Informants 12, 13, and 14 describe conditions required for the success of this hypothetical development. Key Informant 12 believes that it can be hard to train people to accomplish such innovative restoration jobs. This person shares an experience to demonstrate the difficulties to achieve some of them:

> You’re not going to train someone to do what I do. It’s taken me 32 years of doing my trade to get to where I am. So you’re not really going to train. I don’t mean to be arrogant. It’s just it’s a very high-skilled factor. So you’re not going to be able to train someone. In fact, we’ve got our own belief that, myself and my business partner are the only one in 25 doing our trade any good anyway. Because you have to get a passion. If you’ve got a passion for it, you’ll be good. For lots of people, it’s just a job (Key Informant 12).

There are concerns from some key informants whether this specialisation of building professionals is worthwhile locally. Key Informant 14 questions the advantages of specialising as the demand is limited. Key Informant 13 asserts that the market in Dunedin
might be too limited to accommodate a centre of excellence for heritage buildings, supposing that the demand might not always meet the supply. This person predicts that if the demand is insufficient, these professionals will struggle financially or leave Dunedin. Key Informant 13 suggests the development of a website where professionals are rated and recommended to realise some specific jobs, instead of the creation of this centre. This respondent declares to be working on it.

6.3.2. Society

The Consumer Society

The Preference to Use New Products
The reuse of building products is marred by the negative perception of New Zealand society on second-hand building products (Storey and Pedersen, 2003). This situation is perceived by Gorgolewski (2008) who identifies progress, fashion, and the disposability of products as three deterrents to this activity. In general, society is not interested in salvaged products and prefer using new, consumable, and disposable products (Key Informants 12; 13). Key Informant 13 affirms that the evolution of technologies and the relatively low price of new products have led to a new behaviour in our society, with a lack of interest as to the consequences of consumers’ behaviour, unlike what happened in the past:

At the moment, people are buying new stuff. A lot of the young people are not interested in recycling. 30 years ago, we were really into reusing, fixing everything and if something broke, you got it fixed. Nowadays, if something breaks, you throw it away. This whole new generation! If your cellphone breaks down, you’re not getting it fixed. You’re buying a new one. 30 years ago, when I came here in NZ, the radio broke down. You went and got it fixed. But now, when your radio breaks down, you just throw it away and buy a new one... I think it’s a worldwide problem really. I think what happened is that the whole consumer thing, where they keep on coming up with new products and they are coming so fast, that it’s not really worth fixing things. And probably, with this whole thing, everything new and going so fast, people actually never think of reusing something either... If you pull down a house, most people just think that you bulldoze it flat, no thinking about taking the windows out because they can be reused in another building. They don’t do that anymore (Key Informant 13).

This reluctance to use salvaged building products is also established among the building community (Key Informant 1; Storey, 2002; Storey and Pedersen, 2003). The challenge is therefore for society to understand that salvaged products, including building products, are valuable.
Education on Environmental Issues
Many key informants believe in educating society to promote the use of salvaged building products. However, the content of information suggested varies according to the informants. Key Informant 5 and 13 consider informing people on environmental issues, including the pollution associated with the manufacture and the transport of building products to be a positive step to promote the use of salvaged products. Key Informant 13 also suggests explaining to society the advantages of using these products instead of new products. Another perception is expressed by Key Informant 5 who recommends the use of Lansink’s Ladder to make society realise the C&D waste hierarchy and be aware of the alternatives to landfilling this type of waste.

In addition, some keys informants have suggested some benefits of reusing building products that could be integrated in an educative programme dedicated to the population. From an environmental perspective, Key Informants 7, 13, and 14 mention the environmental price of a building and relate it to its life-cycle, similarly to the concepts of green building rating tools (Kibert, 2008). Key Informant 7 explains that heritage buildings in Dunedin have a high amount of embodied energy. This energy and resource are lost when these buildings are demolished and the products landfilled (Saleh and Chini, 2009).

This education would help people understand the value of building products, help develop the marketing of salvaged products and finally encourage their reuse (Key Informant 13). If society becomes aware of these facts and if it believes that building professionals can incorporate salvaged building products into building projects, they may commission some of these products in their building project.

Integrating the Education on the Reuse of Building Products in Existing Programmes
There are programmes developed in New Zealand to educate society on environmental issues, such as the programme Smarter Homes. However, information on product efficiency in sustainable building is incomplete, particularly in the 2008 Department of Building and Housing’s publication. Filling this gap in this programme could help building owners to prefer this activity.

In addition, the sustainable courses for the Dunedin community are a medium to educate building owners to sustainable building issues (Key Informant 8). These educational
programmes, and particularly the course on eco-building in the sustainable courses, have the opportunity to introduce the fact that some building products can be reused. They can also suggest that building owners consult further sources of information if more details are required.

Culture

The Lack of Interest for Heritage Building Products
An opinion expressed during an interview is that although the community regrets the disappearance of any heritage building in Dunedin, and sometimes protests against it, little attention is currently given to the products stemming from the demolition of these buildings. Indeed, some products salvaged from Dunedin heritage buildings have been exported and reused in Christchurch in the past, while others have been sent overseas (Key Informant 5). A view from heritage is that the likely lack of interest by the community of these released products may be explained by the fact that they are not aware of the story behind them. As this person admits: “sometimes, it’s simply about engaging people in stories about the significance of the material”. This person believes that some people are attached to salvaged products as they are a testimony to their personal history: “they want a part of that story, they want a bit of that link”. As this interviewee explains, it is not unusual that some people keep a piece of turf, gravel or a seat when a stadium is refurbished or demolished. This respondent also cites the recent example in Dunedin of the Regent Theatre seats which were given away to the community, which demonstrates the validity of this opinion.

Connecting Society with the Value of Heritage Products
An opportunity is therefore to connect society with salvaged products by relating their history. Key Informants 13 and 14 advocate for education so that society gives a value to salvaged products, especially through their heritage or their rare character. However, Key Informant 10 warns of possible side-effects of a better understanding of the value of products from a heritage building and advises incentives to avoid the salvaging of building products to be more profitable than maintaining the heritage building.

Summary of section 6.3: the building industry and building owners are two groups of stakeholders involved in the reuse of building products who need to be educated to expand this activity. The New Zealand building industry is traditional and does not express any
particular wish to upskill. It has access to a limited amount of information on the reuse of building products. However, many educational organisations exist in New Zealand to support it being more efficient. This educational framework is completed by some recent legislative requirements forcing many building professionals to upskill. These educational organisations have the opportunity to develop a coherent programme to sensitise the building industry to environmental issues and teach them how to be efficient when carrying-out this activity.

The second group of stakeholders is society in general, including building owners. They are, for the most, consumerists, buying new products and discarding reusable ones. Education programmes have to be developed so that this group understands environmental issues and the benefits of reusing building products. Moreover, some salvaged products have a heritage value. People also have to be sensitive to it to preserve their heritage, as a second step, when a heritage building is pulled down.

6.4. The Economy of Reusing Building Products

6.4.1. Value and Cost of Salvaged Products

The Salvaging Activity Driven by Economy

Many key informants agree that salvaging products is driven by economy (Key Informants 4; 9; 12; 13; 14; 17). Key Informant 17 considers that the company employing this person salvages products for the only economic reason that they are too valuable to be discarded. Additionally, this person explains that the demolition activity is becoming uneconomical because of the increasing cost of landfiling rubble. This increase in cost partly results from the waste levy implemented by the government (Ministry for the Environment, 2011c). Key Informant 17 indicates that the price to landfill rubble is approximately NZ$120 a tonne.

The Cost to Use Salvaged Products

The Cost of Salvaged Building Products

Salvaged building products can be uneconomic to use (Kernan, 2002). Although the price of new building products is constantly increasing, the competition with the cost of salvaged products can be fierce (Department of Building and Housing, 2011, Key Informants 12; 13). Storey, et al. (2005) highlight the uneconomic aspect of reusing some inexpensive
building products, such as pine wood whereas Key Informant 12 and 13 criticise the high price of recovered products in salvaged yards. Key Informant 13 believes that this situation reflects the cost of salvaging products (involving labour, cleaning and storage) which can be higher than their selling price. For this person, this situation has led to a certain amount of reusable building products being landfilled.

However, the view that salvaged products are very expensive is not shared by everyone. For some key informants and researchers, they can be economical. Key Informants 12 and 13 state that if products are recovered and reused without the middleman, given away, or bought at a reasonable price, they are more economical than new products (Key Informants 12; 13). This opinion is shared by Gorgolewski and Morettin (2009) who affirm that salvaged products are usually relatively less expensive than new products. In addition, Key Informant 4 sometimes experiences clients asking for a project with salvaged building products accumulated in the past because of their affordability:

It comes down to the owner’s budget I think. There’s a fair number of people out there that feel that they have the right to use things like this. And their whole way of thinking is “I can save several thousands dollars by buying up second-hand goods”. And then they’re just left with labour. They might buy products up for three, four years. Then they finally get the point right. We can afford the 10 or 20,000 now to put this room on cause that’s the labour content, my plans and council application… The man I was talking to on the phone just as you arrived has exactly done that very thing (Key Informant 4).

**Additional Costs Associated with the Reuse of Building Products**

Besides the cost of salvaged building products, side activities can add up to the total cost of a building project. Extra labour, innovation, and research can be expensive (BRE Global Ltd, 2011, Gorgolewski, Kernan, 2002). Key Informants 12, 13, and 15 declare that the cost of reusing building products can be significantly increased if a tradesman is hired to clean them prior to reuse or to find and supply them. The cost of certification to comply with legislation is also a component of the final cost (Hendricks and Janssen, 2004). It is particularly increased if an engineer demonstrates the properties of salvaged products used for structural purposes (Key Informant 2). In addition, the cost of unexpected and unquantifiable delays and issues, such as damaged products, can be so high that it becomes uneconomical to reuse building products (Gorgolewski, 2008). As a result, Key Informants 12, 13, and 15 recommend that individuals reuse products themselves and do not hire any tradesman if they want to save money.
6.4.2. Economic Incentives to Encourage the Reuse of Building Products

Existing Economic Incentives
Some values conforming to the reuse of building products are supported through some economic incentives. Taxes to increase the price to landfill waste and funds to protect heritage buildings are the two main economic incentives available in New Zealand and in Dunedin to encourage the reuse of building products. Key Informant 17 considers the cost of landfilling C&D waste as an incentive for their diversion. Taxing landfill cost has been found to be a remarkable economic strategy by central government as well as the DCC, in Target 28 of its Waste Strategy (Ministry for the Environment, 2011c). In addition, the fund from NZHPT and the local fund from both the DCC and the NZHPT can help heritage building owners to maintain their property, and reuse building products to this end (Dunedin City Council, 2010; Key Informant 5; New Zealand Historic Places Trust, n.d.).

Developing a Competitive System for Reusing Building Products
An informant has an original idea to encourage the reuse of building products. This interviewee suggests advertising this activity as both sustainable and economical for businesses. This person draws a parallel between this activity and the activity of professionals in charge of reducing energy consumption for businesses. Similar to the demand to decrease energy bills, there could be a demand from businesses to reduce the consumption of new building products. Such a scenario would involve professionals sourcing and optionally certifying salvaged products. It would result in a low cost for the supply of building products.

Commercial Value and Aesthetics Associated with a Building with Salvaged Products
Key Informant 1 and 13 suggest that reusing products can personalise a building: “the new products haven’t got the same character as the old material” (Key Informant 13). Key Informant 1 adds that “old timber beams… look good inside a building that’s old, even if old bolts are sticking out of the beams”. Key Informant 13 also considers that using old-looking products instead of new products can be cost-effective in the long-term:
The good thing with the old products is that they all stand the time. If you do it well, the building will always look good. It will be much longer lasting than if the building was fully done in modern products. They are often fashionable. In ten years or twenty year time, it’s not anymore what people like of the look. So often, the mistakes that people make when they use modern products is that they choose products that are from that particular day, so what goes out of fashion. So it will date a building. So if you use products, even if you use new products but you try not to use products of that day, then you’ll probably make it much more lasting building. It will save having to redo it again in twenty years time (Key Informant 13).

In a bigger picture, Key Informants 5, 12, 13, and 14 acknowledge that a heritage building with a traditional historic interior is valuable in finding tenants. Key Informant 5 gives the example of tenants of a heritage building in Dunedin who have chosen their location because of its historical interior character. When referring to these tenants, this person explains a lesson from this experience:

If they [tenants] are going to an older building, they’ll probably go there for a specific reason, because they like that character. So don’t cover that character up, let that character shine, let the material shine through. The building owner might look at it and see worn out edges on the steps on a staircase and think I need to smarten that up. Actually the tenants might like the look of that space as it gives their business a sense of being here a long time. There is all the history behind it (Key Informant 5).

Reusing building products to maintain or renovate a heritage building can be an asset to improve the chances for it to be used. This is particularly important for Dunedin building owners to consider as many heritage buildings are unoccupied. If it can be demonstrated that the occupants of the building live in a better environment when building products are reused, it can become interesting for building owners to invest in it.

**Summary of section 6.4:** there are great uncertainties on the cost of reusing building products. Purchasing these products in salvaged yards can be expensive, but alternatives exist to obtain them for a relatively low price. Additionally, employing building professionals to source and restore building products can be too expensive and deter building owners from requesting it to happen. On an economic perspective, building owners should select and prepare salvaged products as much as possible.

Diverse economic incentives are suggested to encourage the use of salvaged building products. The waste levy has a positive effect on C&D waste management as it encourages demolition companies to salvage and sell recovered and valuable building products. Creating an economical service for businesses to get building products could encourage them to commission this service. Finally, renovating and maintaining a heritage building
without transforming its style can be an economic asset for its owners, favouring its occupancy.

6.5. Legislation

6.5.1. Planning Law

Reusing building products aligns with the philosophy of some legislation, as depicted in Chapter Four. Local governments take community desires into account with the Long-term Council Community Plan and can create their local legislation following the content of the Local Government Act 2002. The reuse of building products is also coherent with the philosophy of the Resource Management Act 1991 and of the heritage legislation (Key Informants 3; 5).

However, literature has revealed that the New Zealand government could be more supportive of the reuse of building products in heritage. One opportunity is to follow the example of some local councils in Canada which have investigated the protection of products issued from heritage buildings (Regina City Council, 2001; The Heritage Advisory Committee of Aurora, n.d.). This approach could be adopted at a national level or at a local level. One view from the heritage industry suggests that the Dunedin City District Plan could be altered to better reflect this preservation of heritage, if the community required it during the consultation process.

Waste Legislation

The waste legislation is supportive of the reuse of building products in theory. The mechanisms in the Waste Minimisation Act 2008 favour this activity. The hierarchy of waste management and minimisation strategies, detailed in the definition of the term ‘waste minimisation’ in section 5 of the Act, encourages this activity over their recycling and their recovery. Economic incentives with the waste levy and the waste minimisation fund drives the building and demolition/deconstruction industries to rethink their waste consumption (Part 3 of the Act).

Another key point of the New Zealand waste framework is that the government considers waste as a significant issue (Ministry for the Environment, 2010b). The coherence between the New Zealand waste strategy, its national legislation and local planning legislation is also an asset, insuring that this strategy is considered at all levels (Ministry for the
Environment, 2010b). Similarly, at the national level, the ORC considers waste as a significant issue within its regional waste strategy, as does the DCC for its territory with its waste recovery strategy (Dunedin City Council’s Resource Recovery and Waste Working Party, 2006; Otago Regional Council, 1998). However, the current waste legislation is not perfect yet, as it is hard to obtain reliable statistics on C&D waste production, although the DCC is working on it, as detailed in Chapter Five.

Other laws, like the Climate Change Response Act 2002, which relates to an emission trading scheme and to the polluter-pays principle, help New Zealand society to rethink their waste production (Pearce, 2006; UNEP Industry and Environment, 2003).

6.5.2. The Building Legislation

A Legislation Hindering the Automatic Reuse of Building Products for the Structure of a Building

The building legislation appears favourable to the reuse of building products. The Building Act 2004 has some guiding principles for sustainability, including references on an effective use of building products and on resource conservation (section 4 of Building Act 2004). The like for like principle which allows reusing building products, although not specified in the Act, is followed and accepted by the building industry (Key Informants 3; 4; Pringle, 2008).

A further analysis of the building legislation reveals that it can prevent the reuse of building products to happen. The building legislation is not entirely favourable to sustainability, although some references exist. Key Informant 7 recommends more innovation and advises that a revision of the New Zealand Building Code is needed to integrate several sustainability criteria, including an emphasis on the consumption of local resources. This could help promote the salvaging and the reuse of building products.

The building legislation is also developed for safety reasons, preventing an uncontrolled use of salvaged products in the structure of buildings. As Key Informant 8 emphasises, legislation is designed to work for the majority of people and to ensure buildings are safe enough to be occupied. Moreover, the like for like principle, is unclear and on a case by case basis requires clarification from the building consent authority to know the building products that need to be certified (Pringle, 2008).
The Difficulties in Getting a Consent to Reuse Products for Structural Purposes

Many key informants acknowledge the difficulty of going through the regulatory process in order to be allowed to reuse products in the structure of a building (Key Informants 1; 2; 5; 7; 14). Key Informant 5 affirms that only the people determined to reuse salvaged products for the structure of a building succeed going through this process:

I think the biggest inconvenient [problem] to the owner at the moment is to try to get things [applications] signed off so that it [salvaged building product] can be reused. That’s the big challenge because our standards are set very high in the New Zealand construction industry. The people that have succeeded most often are those that have really thought quite hard to be able to reuse those products.

Key Informant 4 and 14 explain that this difficulty is the consequence of the nature of the application for a building consent. Key Informant 14 states that “there’s no doubt some of those regulatory schemes or the regulatory environment does put up barriers to reuse. So, alternative solutions are generally harder to get through the system than the ones that are approved”. In this statement, Key Informant 14 refers to the difference of treatment for acceptable solutions and verification methods to alternative solutions. To use alternative solutions, their benchmark has to be demonstrated, as stipulated in The Compliance Document for New Zealand Building Code Handbook (Department of Building and Housing, 2006).

Key Informant 1 considers that the legislation is currently sufficiently restrictive: “I don’t think you need more rules in the building industry to hold projects up. I mean there are enough rules now… and it costs money”. Key Informant 4 agrees: “applying the Building Code, and getting everything organised for council’s application, that’s a headache for us”. This negative perception of the building legislation is notable due to its revision, which has resulted in more constraints for the building industry. This point is detailed in the next section.

A Stricter Building Legislation Requiring More Information for Building Consent Applications

The revision of the Building Act has resulted in new requirements for the building industry to comply with (Key Informants 4; 9; 14). The building professionals discussing this point agree that this review of the legislation has impacted on the workload of architects and designers (Key Informants 4; 9; 14).
Key Informant 4 identifies changes, notably in the building consent application process. According to him, the DCC designed checklist accompanying a building consent application is often updated. This person explains that although the document has been in place for about three years, it is currently on its seventh version. Following the changes in legislation, Key Informant 4 indicates receiving letters requesting further information from the building consent authority, generally requiring details of specifications. This respondent has kept a record of them since they appeared and has been able to track them back to 2006. As this interviewee emphasises, “there’s a good reason to contact us but this has never happened before. This is all part of this new change again” (Key Informant 4).

Key Informant 4 reports constant changes in the legislation, perceived as occurring as often as every two or three weeks. This person indicates that this new legislation implies a revision of the specifications worked on and an update of the software used accordingly. One of the consequences of this new and stricter legislation is a greater workload for architects and designers to demonstrate that their specifications comply with the Building Code. Key Informant 4 is the only interviewee who expanded on this fact. This respondent gives an indication of the workload he has to provide for a simple project:

Admittedly, the documents are getting bigger and bigger. The other day, I had a pile here, a 186 sheets in one specification. It was that thick… 300 hours went in for an alteration job if you can imagine that, that’s unbelievable. And 22 sheets of drawings, alteration to a house... but I had to cover everything… It can get very complex… I’ve got to show the reasons why we’re using this material and how it satisfies this and quote precedents that have happened in the past... All that takes time, heck of a lot of time (Key Informant 4).

To conclude, Key Informant 4 notices that all these changes are “a great big turnover as opposed to the sleepy old Code that we used to have”. This person further illustrates this statement with a comparison between the situation in the 1970s and now:

Back in 1970, we could put a set of house plans in, which was three sheets and you didn’t even need to talk about the window flashings, you showed the window and you were happy. Sometimes you didn’t even show the ventilation component in the window. That same building would now be up to six or seven sheets. We’ve doubled the amount of documentation (Key Informant 4).

These statements illustrate that the building legislation requires a greater workload for designers and architects, which explains why some of them refuse to be involved with salvaged building products. Despite these difficulties following the revision of the building
legislation, Key Informant 14 believes that the latest review of the Building Act has relaxed the existing legislation:

The latest review, the 2009-2010 Building Act review, is trying to rebalance, perhaps, some of that strictness that came into the regulation and in the legislation. I guess there was a lot of noise that it was becoming too hard to build buildings because of all the legislation and red-tape. That has arisen, partly from the 2004 Building Act.

Key Informant 14 adds that the Department of Building and Housing is going further in the revision of the building legislation process and is currently considering some initiatives to give more freedom to designers while at the same time giving them more responsibility. This revision of the building legislative system could provide some opportunities to support the reuse of building products for structural purposes.

The Building Professionals’ Preference for Acceptable Solutions

A view from the industry suggests that the building community likes acceptable solutions because they provide some certainties. The experience of Key Informant 4 confirms this statement. This person avoids as much as possible to deal with alternative solutions because they entail a more complex process: “it just involves more time and effort, research and basically the client doesn’t want to do that”.

The building legislation can be so demanding when projects do not follow a main-stream approach that it prevents the industry to innovate. Key Informant 4 confesses trying to use standard solutions as much as possible:

If someone comes to me and say we want to build a house out of car tires and so on, I would probably say I’d rather not. Ten, 20 years ago, I’d probably had say yes because I’d probably treated it as a hobby... And I had few of these jobs in the past, I’ve done few really strange things. It could take me a day just trying to work out what I’m likely to be required to present to obtain a consent… You can see what we get into. It goes on and on. Frustration is probably the word, so we try to avoid all that.

The Liability and Responsibility of the Building Industry

Currently, many stakeholders can be held responsible in the event that a default happens in a building. A view from the industry mentions the ‘joint and several liability’ of building professionals working on a building project. In case of a conflict, contracts set prior to undertaking a building project are consulted to define the responsibility of everyone. This is confirmed by Kernan (2002). The second step is for the Court to determine who the parties responsible of the defect are. For example, these parties can be the designer, the
According to Key Informant 14, the limit of responsibility is set to ten years in the building legislation while contracts, although all different, usually set up a period of responsibility of six or seven years. After this period of time, responsibility for any defect is over. As a result, this interviewee explains that if a wall becomes defective after 10 years of existence and before 50 years of supposed durability, nobody is responsible for it, even if the specifications have taken into account the durability clause in the Building Code.

The national ‘leaky home’ issue in New Zealand has created a precedent regarding the approach to liability in the building industry (Key Informants 4; 12; 13; 14). Architects and designers are now required to get professional insurance to be able to be part of this professional body (Key Informant 4). An interviewee has identified side-effects on the building community that ensued this national issue, particularly a greater apprehension of the industry on their responsibilities and liabilities when being involved in a building project:

What the leaky homes crisis did was bring into sharp focus people’s responsibilities and liabilities. There’s a subtle difference between a responsibility and a liability. People’s responsibilities are spelt out in various ways. So there’s some legislation on responsibilities and those are in the Building Act and it spells out what they are. There are also responsibilities under contracts. Outside of the Building Act, you’ve got a whole bunch of commercial contracts with people who have got responsibilities and liabilities. The leaky home crisis has reminded everyone that they have some liabilities, so trying to protect themselves, I suppose, from too much exposure. Generally, I suspect and I can’t be sure of this, it’s just a sort of personal view, most people are happy to stand behind their own work. But I think with the leaky buildings, it was systemic. And because of that, people are aware that they could be held to account for other people’s problems as well as their own or other people’s failures, even if they had done a perfectly good job themselves. So in trying to protect that, I think people became afraid of this. So it’s not just councils, it’s everyone in the profession. And so, for the reuse of products and things that are a bit leading edge or cutting edge; that means that people are less willing to go there. And there are a number of barriers around that.

The attitude of some building professionals towards the reuse of building products is reflected in the perception of this interviewee. Key Informant 4 as an architect is considered to be the specifier and as a consequence is liable and responsible for any failure, explaining the reluctance of architects and designers to reuse building products. Builders seem to face the same fears as designers, with Key Informant 1 stating not to reuse “any of these products unless the client insists”. This liability attached with the reuse
of building products is also identified by Storey, *et al.* (2003) and by Gorgolewski (2008) who emphasise the fear of risk-taking by building professionals when prescribing salvaged products.

**Opportunities in Building Legislation**

Key Informants 1, 4, 5, and 11 support the relaxation of the law relevant to the reuse of building products in the structure of a building to encourage it, and particularly recommend a review of the building legislation. The alternative solutions are hard to demonstrate and the strictness of the legislation results in the building community sticking to acceptable solutions. A more straight-forward system for filling applications involving the reuse of building products could facilitate this activity.

This strictness of the legislation is also understood by the Department of Building and Housing, as they are researching on ways to revise the building legislation and offer more opportunities for the industry to innovate (Key Informant 14).

**Summary of section 6.5:** planning, heritage, and waste legislations are usually favourable to the reuse of building products. However, an opportunity is there for the heritage legislation to be reviewed so that it gives a status to protect the released building products.

The building legislation has a more balanced position on the reuse of building products than the previous types of legislation. Although it contains some references to an efficient use of building products and to resource conservation, the building legislation aims to ensure building occupants’ safety. For this reason, the quality of salvaged products has to be proved. Generally, the building legislation has become stricter over the years and has prevented the building industry from innovation. The liability and responsibility of the building industry are established and are a second impediment for the reuse of building products. Relaxing the building law may be an option. However, research is needed to measure the level of freedom that building professionals can obtain to encourage innovation, while ensuring safety.
6.6. Leadership

6.6.1. Overview

Key Informant 13 believes that there is no incentive from the government to encourage society to reuse building products neither in Dunedin, nor in New Zealand:

There’s no incentive for the government to recycle and that often makes it more difficult actually. Because if you want to reuse old products, often if it was used in a structure, you need to get an engineer’s report on that thing. They really make it difficult for you to use it in certain circumstances. They don’t have incentives or promote the reuse. Even in building new, you’re even not allowed to use second-hand products. That’s another thing. It will actually even more discourage people to use them.

This point of view is supported by Key Informants 2, 4, 7, and 15. Key Informant 4 adds that there is no publication dealing with the reuse of products and their possible application from a legal perspective. In addition, all the key informants state that the Building Code is too restrictive to allow this activity to happen. To summarise the situation, Key Informant 4 states that: “that sort of thing is on the go but government doesn’t encourage it at all. Council doesn’t encourage, nobody encourages it. You have to fight for it”.

Balancing this thought, Key Informants 7 and 14 refer to national independent organisations that indirectly support the reuse of building products. Key Informant 7 mentions the Green Party who by nature is interested in preserving the resource. This interviewee and Key Informant 14 also indicate that the NZGBC makes some references to the reuse of building products. Key Informant 14 also adds that BRANZ is pro-active in research on sustainable building.

This chapter has already covered the role of research organisations and of the building industry. The next sections therefore discuss the role of central government, local government, and society in encouraging the reuse of building products, and discuss the implications for this multiplicity of stakeholders.

6.6.2. Central Government

A Limited Involvement in Green Issues

Despite the presence of numerous stakeholders in the New Zealand context who could encourage the reuse of building products, Storey and Keane (2008) discern the absence of a national strategy for it. There is notably a lack of clear support from the government. The
building industry, as a whole, supports this statement (Key Informant 4; 13; 14). In New Zealand, Storey, et al. (2003) indicate a lack of green government procurement strategy from central government, which could encourage the reuse of building products in public agencies (Storey and Pedersen, 2003).

As presented in Chapter Four, central government could be involved through some of its ministries and agencies in the salvaging and the reuse of building products. Overall, the Ministry for the Environment, the Department of Building and Housing, and the NZHPT do not strongly promote these activities. However, according to Key Informant 10, the heritage organisations sometimes recommend salvaging, on a case by case basis, when a consent is sought to demolish a heritage building.

Opportunities

Many stakeholders recommend that central government should promote the reuse of building products and they express various opinions. Key Informant 15 imagines the Department of Building and Housing being a leader for this cause “because they’re a government department”. Generally, Key Informant 5 believes that central government needs to consider and develop a framework for this activity, involving research and a specific legislation that does not fully hinder the reuse of products. Key Informant 13 suggests that the government could help provide advice in finding salvaged products and in their reuse. This informant believes that keeping the cost of these products low and the creation of a market platform would support this practice.

The government has tried in the past to set a good example by recommending sustainability for their offices through the ‘Govt programme’ and have used the Greenstar as one of the criteria to define a sustainable building (Office for the Minister of the Environment and Office of the Minister Responsible for Climate Change Issues, n.d., Key Informant 14). However, this programme did not run long enough to influence New Zealand building practices. There is an opportunity for the government to adopt a similar programme, where the reuse of building products would be promoted.

There are opportunities for central government to integrate the reuse of building products into existing programmes, especially those on sustainable building. Their scope could be extended to integrate this activity. For example, sustainable building is a concept not expressly mentioned in the New Zealand Urban Design Protocol, a voluntary programme
that many local authorities, government agencies and other agencies have joined (Ministry for the Environment and Urban Design Advisory Group, 2005). It is becoming an ideal and a guiding strategy for the future as it is cited as a concept of reconstruction for Christchurch as well as being a recommendation to further develop the University of Otago. Referring to the reuse of building products in this broad programme would encourage this activity.

6.6.3. Local Government

Overview

A Multiplicity of Roles
The literature issued by the DCC reveals that it plays many roles in developing and implementing legislation, funding projects, leading the way on some projects supported by the community, in solid waste management, heritage buildings, and more generally in planning, as does central government (Dunedin City Council, 2007; Dunedin City Council’s Resource Recovery and Waste Working Party, 2006).

Positive Feedback on the DCC Involvement on Sustainable Issues
Many key informants consider that the DCC has made some improvements on sustainable issues over the last few years (Key Informants 5; 6; 7; 8). Key Informant 8 states: “I think that this council is good. When I listen (to) people talking about other councils, I think our council has really progressed”. The DCC has engaged to the Zero Waste programme and supports a local waste exchange programme (Forsman, 2011; Zero Waste New Zealand, n.d.). Efforts to reduce C&D waste are visible from both the ORC and the DCC, who encourage deconstruction and the recovery of building products (Key Informants 6; 17). Regarding heritage, the DCC encourages its preservation through programmes, such as the Dunedin re-use award for heritage buildings. This is an opportunity for building owners to demonstrate how reusing building products can help successfully renovate them (Dunedin City Council, 2011b).

Key Informants 7 and 8 attribute this progress from the DCC to both the staff and the councillors. The DCC is open-minded and discusses issues within its departments and with third party organisations (Key Informants 2; 5; 6). Key Informant 6 is involved in the group ‘Business for Change’, a local think-tank tackling waste issues, who had one session devoted to the reuse of building products. Key Informant 5 also affirms having considered
the future of building products with a staff member from REBRI who is now working on the residual life of products. This project began last year but has not progressed as rapidly as this staff member from the DCC wishes, given that it is not a priority for the DCC. Nevertheless, Key Informant 5 has some contacts with the University of Auckland regarding earthquake-prone building strengthening and declares being interested in working on heritage building products recovery and reuse with any research organisation.

**Opportunities**

**C&D Waste**
As presented in Chapter Five, the DCC is working on collecting reliable data on local waste production to inform and revise its waste framework. If the data collection findings prove that C&D waste is a significant waste stream landfilled, reusing it can be sought as an alternative to its disposal. Moreover, following their commitment to the Zero Waste Programme and to the waste exchange website, the DCC has the opportunity to better inform the community on these existing programmes and encourage locals to reuse building products under these schemes.

**Building**
The DCC building department is not favourable to the reuse of building products (Key Informant 2). It does not require any waste management plan with any building consent application (Key Informant 6). An opportunity for local government is to carry out research on the implications of requiring this additional paperwork for the building industry.

Furthermore, to assist the community in sustainable building, Key Informant 8 refers to good practice on sustainable building in New Zealand. The Nelson Council has an eco-design advisor who can be consulted and can provide recommendations on building sustainably. According to Key Informant 8, this person can also inform anyone of the places where discarded C&D waste can be obtained. This interviewee believes that offering such a service in Dunedin would benefit the residents and rate-payers and could promote the reuse of building products.
Heritage
From a heritage perspective, the DCC heritage strategy does not include any reference to the salvaging of any building product if a building needs to be eradicated. As stated in section 6.5.1, this planning document could be revised to include this new strategy for heritage preservation (Dunedin City Council, 2007).

Key Informants 10 and 13 suggest the creation of an area where heritage building products could be stored. This would allow their preservation, instead of their landfilling. As a funder, the DCC could support this practice, and offer spaces and warehouses to store building products.

6.6.4. Society and Exemplarity of Individuals

The Need of Society’s Request to the Government
Many interviewees believe in the power of society to change the government’s attitude on the reuse of building products. A finding from the interview process has exposed the decisive role that the public plays in making the reuse of building products more common. Key Informant 10 highlights that city and district councils adopt incentives and rules that are community-driven. Society needs to demonstrate their wish for this activity to happen for the government to react accordingly. Some informants also suggest that it is the role of society to ask for the salvaging and the reuse of products as they think that the local government will not adopt any measures to encourage these possibilities otherwise (Key Informants 5; 13; 14; 15). A way to make people hear their voice is through the submissions in the long-term council community plans. The wishes from the Dunedin community are in accordance with the values of reusing building products, which has the potential to back up the move of the DCC to better support this activity (Dunedin City Council, 2009).

Key Informant 14 refers to the strength of public opinion to make the legislation evolve. Key Informant 4 has a similar opinion and considers that landowners, who spend their money buying building products, have the opportunity to ask for change if they are organised into a lobby group. Key Informant 15 believes that the first step to encourage the reuse of products is to get some local support and involve a member of parliament. Key Informants 7 and 15 suggest that the political organisation ‘Green Party’ has an
environmental ideology and can promote the salvaging and the reuse of building products at a national level and make the government adopt some policies.

The Exemplarity of Individuals

The role of individuals is crucial to demonstrate that reusing products is possible according to Key Informant 5. This interviewee refers to some locals in Dunedin who carry out this activity on their property and could be leaders advocating for it:

There would be cases, and again this is where people are more motivated; they would find a sort of way around to changing the type of glass which is in the window, like the guys who have been retrofitting double-glazing to all of the units. You would say in 90% of cases, if anyone did that, they would just replace the whole window. They would just probably have stuck in aluminium double-glazed windows. These guys said: “We want to keep the original windows” so they just install [them]. It’s a very fiddly work to do that, and it’s fantastic they are. Again it’s because they are kind of perfectionists and they really want to do a good job and respect the building.

The participation of these individuals in programmes such as the mediatised re-use award help educate society on the benefits of reusing heritage building products.

6.6.5. A Multiplicity of Stakeholders

The literature has revealed that a multiplicity of stakeholders can be problematic for the reuse of building products. The current absence of network between the building and the demolition industries is particularly highlighted by Gorgolewski and Morettin (2009) in Canada and by Storey, et al. (2005) in New Zealand. The situation in Dunedin suggests that this statement is not totally true in the local context. Although the testimony of Key Informants 12 and 13 confirm this literature finding, the experience of Key Informants 9 who sometimes shop in salvage yards limits the generalisation of this statement. Moreover, the demolition and salvaging company employing Key Informant 17 and supplying some builders, supports the hypothesis that some connections between some building professionals and some salvagers exist.

Beyond this potential lack of network between the building and the demolition and salvaging industries, another problem is the inefficient communication within the building industry. This industry is known for their difficulties to communicate with their partners (Koskela, 2008). Key Informant 4, an architect, illustrates some experience of the lack of dialogue of builders, potentially being an unfortunate experience if these stakeholders end up reusing building products for the first time:
A lot of them [builders] can’t communicate. They don’t know how to communicate. They don’t know that it’s the owner, me, and them still involved when they’re doing the work. Of course, the council is another party. And a lot of them can’t see in advance a problem coming up. Some will continue on with the problem and deal with that themselves. And then, we’ve got a nasty thing happening at the very end. But they didn’t say anything at the time, they didn’t contact me.

Despite the lack of network within the building industry and between the industry and other industries, some positive connections are noticeable. Some building organisations are already connected into a network. REBRI gathers BRANZ, central government, some local councils, and some building industries (Building Research Association of New Zealand, n.d.-b). In addition, the programme Smarter Homes has resulted in the co-operation of the Department of Building and Housing, the Ministry for the Environment, and the Consumer association.

Many stakeholders are likely to be involved in the reuse of building products, meaning that all of them have to be convinced for this activity to become more popular, even those with conflicting interests (Kernan, 2002). The multiplicity of stakeholders likely to be involved in the reuse of building products means that a network has to be set up. It also suggests that there is a potential for a widespread awareness of recovering and reusing building products in building, solid waste management, and heritage. The opportunity is for the leaders of this activity to involve the other stakeholders in their approach.

**Summary of section 6.6:** currently, there is no leadership to reuse building products from anyone. Central government has limited involvement in green issues but has the opportunity to be a leader by commissioning them through its government agencies. Local government, particularly the DCC has made progress in considering sustainable issues, including waste management, and heritage. They have the possibility to extend their leadership by leading some programmes in building, solid waste management, and heritage. Society also has a critical role to play in lobbying the government for this activity to happen. Moreover, individuals presenting successful projects where building products are reused could be the catalyst for this activity to expand.
6.7. Summary

This chapter has presented the results of the interviews of selected Key Informants in light of the findings from the literature review, and of the local context. The interviewees have provided information on the practice of reusing products, and detailed the precautions necessary to consider prior to carrying out this activity when responding to questions developed around the themes identified in the literature review. They have been critical in their intervention and have raised side issues such as the leaky home issue which has highly influenced the building community.

The key points of this chapter are that legislation is perceived as a great barrier to the reuse of building products in the structure of a building, and deters many building professionals to undertake or support this activity, as anticipated in Chapter Four. Generally, key informants support the idea that there is not enough promotion of the reuse of building products, both towards the building community and society and that there are insufficient economic incentives to preserve heritage elements. The reuse of building products is also considered to be against consumerism, although it aligns with the relatively recent waste minimisation strategies and the sustainable building practices. Nevertheless, it appears that some individuals and organisations are more conscious of the advantages of reusing products in Dunedin, contrary to the majority of society. These stakeholders could set the example to encourage this practice. Finally, key informants have suggested some strategies to promote this activity. The next chapter concludes this research and presents some recommendations to encourage the reuse of building products.
7. Conclusion and Recommendations

This research has presented the case study of Dunedin to explore how building products are reused in low-growth cities in New Zealand. A review of the literature on sustainable building, the efficient use of building products, and C&D waste management has shown that there is a gap in literature on the reuse of building products, particularly on the technical way to incorporate salvaged products into the building process and on the legislative framework. Theories relevant to the reuse of building products have been examined during this process, helping define the research questions and allowing a good understanding of the research issue. It has also presented some potential opportunities for this activity to extend.

The adoption of a research design has later prepared the research process. Then, the study on New Zealand and Dunedin has focused on their economic and legislative contexts, and the identification and examination of the stakeholders likely to be involved in this activity. The relevant legislation, policies, plans, and strategies have been identified and analysed. The literature review and the exploration of the local context have influenced the choice of key informants selected for this research. These building and waste professionals have provided valuable information in accordance with literature theories and even completed it. They have particularly helped draw up an overview on the extent to which the building industry uses salvaged products. The analysis of the Dunedin context, in light of the theories in literature has resulted in the identification of some positive and negative factors affecting this activity. Some of these barriers can be lifted. These opportunities have then been discussed to form the final recommendations.

This study aimed to evaluate the feasibility of product reuse in the New Zealand building industry and to present recommendations to extend this practice. For this, three research objectives were set up. Objective One was addressed in Chapter Four and in Chapter Five. Objective Two was covered in Chapter Two, Chapter Four, Chapter Five, and Chapter Six. Finally Objective Three ‘to develop recommendations for the building industry to encourage the reuse of products in Dunedin and more generally in New Zealand’ is covered in this chapter. These recommendations are not listed in a priority order; they are designed to be considered together as part of a cohesive approach and integrated package.
The reader should note that these recommendations are two-fold; they apply for Dunedin and low-growth cities but can also be adopted at a national scale. Therefore, section 7.1 presents some recommendations encouraging salvaged building products to be reused in Dunedin and in New Zealand, while section 7.2 concludes this thesis.

### 7.1. Key Findings

Consumerism associated with unsustainable building practices and an inefficient C&D waste management means that resource is wasted. Reusing building products is generally an uncommon practice and is insufficiently researched, but some data suggests that this activity can be beneficial in the future for environmental reasons and for heritage preservation. Furthermore, it can encourage some local economic development with the development of a new profession and with the protection and maintenance of the townscape that tourists visit.

Overall, this research has revealed that using salvaged building products in New Zealand is complex, particularly when they are employed for the structure of a building. There is notably an absence of a national strategy to decrease this waste production and a lack of awareness of this possibility. Overall, five sectors have been highlighted that prevent an extension of this activity: research, education, economy, legislation, and leadership. A summary and some recommendations are provided in the following sections.

#### 7.1.1. Research

**Developing Research on Some Topics**

A lack of research on some topics is manifest in New Zealand. There is notably a lack of information on how common reusing building products is. None of the key informants could be considered as a spokesman of society related to this activity. The information provided during the interviews was more an opinion of the key informants according to their own experience than an accurate assessment. A better understanding of the Dunedin community desires and whether New Zealanders wish to reuse products, whether in the structure of a building or to decorate it, is essential to develop appropriate incentives to promote this activity and inform the need, or not, to revise the legislation to create a specific framework for this activity.
Building practitioners usually deplore the uncertainty associated with the quality of salvaged building products. Research to provide more confidence on use of salvaged products is generally missing, both internationally and nationally. Admittedly, research on the reuse of building products is difficult given that it requires studying a variety of building products, identifying, and assessing the effects of the different deteriorations that these products undergo. However, clear directions and preparation details for different bodies of building professionals to reuse products could encourage them to adopt this activity. Future research on completing forms for consent applications and development of technical advice to make this activity profitable, would assist the building industry.

A third research programme could consist of looking at ways to revise the building legislation to offer more freedom for the building industry to be innovative. The statute of liability and responsibility of building professionals could be reviewed to revive this industry. As the legislation is developed to ensure the safety of building occupants, this aspect of the legislation cannot be negotiated over the reuse of building products.

Therefore, **Recommendation One** is to: further research to understand the reuse of building products in New Zealand and develop a series of incentives to promote and optimise this activity.

In Dunedin, the University of Otago and the Otago Polytechnics have the opportunity to research the reuse of building products. Diverse departments of these organisations are already participating in the Sustainable Habitat Challenge, promoting this activity in its programme. They can further their involvement by researching and documenting good practice on this activity. Other departments from these institutions, such as the law department could investigate ways to revise the legislation to reconsider the statute of building professionals. The DCC also has the opportunity to collect statistics on the number of building and resource consent applications involving salvaged products.

In New Zealand, a network of research organisations could consider the efficient recovery of products and work on a way to provide more certainty to reuse building products, as it is essential to help the industry be more efficient, economical and sustainable. International and national building and waste research organisations, universities, BRANZ, the NZGBC, the Zero Waste New Zealand Trust, the Waste Management Institute of New Zealand, Ministry for the Environment, the Department of Building and Housing, and the NZHPT
could develop this national network with the building, demolition and C&D waste industries.

**Integrating and Promoting the Reuse of Products in a Wider Framework**
The reuse of products is hardly treated as a singular, independent topic, and is embedded with other notions such as the efficient use of building products, deconstruction, design for deconstruction, sustainable building, C&D waste management, and heritage protection. Although integrating the research on this activity within these broad research topics can promote it, there are risks that it loses its significance among other criteria. For example, the emphasis is on energy consumption in sustainable building. However, the reuse of products, treated as a single topic, might be too insignificant to be considered on its own.

Therefore, **Recommendation Two** is to: encourage the promotion of the reuse of building products within broader research topics so that it is integrated in a more well-known theme and does not lose its significance among many other considerations.

In New Zealand, and in Dunedin, the promotion of the reuse of building products within broad topics guarantees that its environmental and historical benefits are taken into account and understood by the researchers and their audiences. This suggests that more research on the reuse of building products is undertaken in different fields, resulting in different industries becoming aware of it, understanding its significance, and integrating it in their activity. Therefore, the reuse of building products can be promoted within sustainable development practices, better integrated in sustainable building criteria, in C&D waste hierarchy, in deconstruction, and in heritage.

### 7.1.2. Education

In New Zealand, the building industry and generally, society are not sensitive to reusing building products. The building industry is depicted as conservative, insufficiently innovative, and reluctant to upskill. Society is usually consumerist, wasting valuable resource. Findings from the interviews show that generally building professionals are not aware of the results of international building research and of international good practice.

Therefore, **Recommendation Three** is to: develop educative programmes for the stakeholders potentially involved in the reuse of building products.
Society, well-meaning individuals, building owners, government and building professionals have to be educated on the meaning of reuse and recycling so that they have a common understanding of these activities and talk a common language. Education has to be developed for these groups so that they adopt a different approach and have a favourable opinion to the use of salvaged building products.

It has been mentioned that using a visual help such as Lansink’s Ladder would make society aware of the C&D waste hierarchy and progressively generate change in their habits. In addition, by demonstrating the ecological, economic, and historic value of building products, society could understand their significance, recover them and use them locally if a heritage building has to be demolished.

Many options are available for organisations in charge of education. They could lobby the government to adopt this practice in its offices, similarly to the Govt3 programme, to raise awareness and illustrate good practice. Good practice examples could be displayed in publications, leaflets, and on the internet. In addition, site-visits could be organised in places where reused products are visible, and difficulties and their solutions could be discussed. This education programme could be developed for both society and building professionals. Educating the building industry on this issue could optionally be part of the continuing professional development of the licensed building practitioner scheme. Publishing in professional publications is also a way to reach and to make the industry aware of sustainable issues.

In Dunedin, the University of Otago and the Otago Polytechnics could refer to the reuse of building products in their programme. The DCC could educate the community on the reuse of building products with the presence of an eco design advisor. This professional could be an intermediary transferring the results of research to the community.

In New Zealand, the licensed building practitioner scheme could offer seminars on the reuse of building products to building professionals. Universities and the BCITO could sensitise their students on this activity. The Ministry for the Environment, the Department of Building and Housing, and the NZHPT could promote the reuse of building products within their sustainable programmes. In addition, non-profit organisations on sustainable building and solid waste management could support the education of the community on this activity.
7.1.3. Economy

In New Zealand, the economic character of reusing building products is uncertain. However, it plays a decisive role as the building industry is driven by economy. The waste levy and the constantly increasing price of new building products might in the future make society reconsider the use of salvaged building products. Research on ways to improve the efficiency of the building industry to reuse building products and the transmission of these findings to building professionals will help them make profit.

7.1.4. Legislation

Revising the Liability of Building Professionals when Reusing Products in the Structure of a Building

Most building professionals have explained their unwillingness to use salvaged products in the structure of a building given the liability attached and the complex legislative process they have to go through. This is partly due to the fact that New Zealand has currently no legislative incentive specific to building products reuse. It is believed that the Department of Building and Housing is considering giving more freedom to the building industry by giving them more responsibility.

Therefore, **Recommendation Four** is for the Department of Building and Housing to:

*revise its legislative framework to encourage the building industry to innovate and be more sustainable when considering giving more freedom to this industry.*

In New Zealand, the Department of Building and Housing will enforce its licensed building practitioner scheme and require the industry to be licensed to undertake some restricted building works by March 2012. There is an opportunity to develop and broaden the revision of the building legislation to encourage builders to adopt more sustainable practices in their trade. This opportunity would also have positive impacts in Dunedin as the DCC would execute this legislation. Because of the difficulties of asserting any further recommendations on this legislation review, the researcher advises more research is needed on this topic.
7.1.5. Leadership

Creating a Leadership to Reuse Building Products

Reusing building products is an activity involving many stakeholders, including politicians, legislators, researchers, educators, planners, solid waste managers, building professionals, heritage conservators, building owners but also government agencies and local governments. As the emphasis in the literature is on the need for a network between the building industry and the demolition industry, a common platform for these stakeholders to discuss the issues preventing the reuse of building products is essential to a common understanding of the role of each stakeholder.

The reuse of building products is an activity insufficiently studied, needing more research on both the Dunedin and New Zealand context, and more research on ways to make it efficient. It also needs to be taught to building professionals who can extend this practice. A common platform would allow the stakeholders to combine their efforts and to share the cost of carrying out these tasks.

Therefore, Recommendation Five is to: create, on a long-term perspective, an umbrella body supervising and combining national research, and ensuring its transmission to the stakeholders.

In Dunedin, the network of stakeholders Business for Change has been created to discuss waste issues including the reuse of building products. This group could be in charge of promoting this activity as it gathers the most influential stakeholders, such as staff from the DCC, staff from universities, and some building professionals. It could be more inclusive and extend to integrate all the stakeholders relevant to the reuse of building products, e.g. some individuals who have some experience reusing building products and some local politicians who have the power to make it a political topic.

In New Zealand, the reuse of building products is encouraged by the NZGBC, BRANZ, and by the NZHPT on a case-by-case basis. An authority could be set up at national level to achieve a greater influence than local networks can. This network could gather the organisations quoted above, the Department of Building and Housing, the Ministry for the Environment, universities and polytechnics, voluntary organisations specialised in waste or sustainable building, and the representatives of the building industry. Local networks such
as ‘Business for Change’ could have the opportunity to elect a representative participating in this national network.

This network would concentrate the efforts of different organisations on a national scale. It would take on the leadership role on promoting the reuse of building products, supported by local networks. Some cohesion would be needed at a national level, resulting in an organised and sound research movement. This organisation could also ensure the education of society on these topics, through diverse media forms.

**Involving Stakeholders on the Relevant Topics of the Reuse of Building Products**

Sustainable building, although acknowledged in Dunedin and in New Zealand, is not widely applied by building professionals. C&D waste is not considered as a priority in solid waste management and waste is more considered as a landfill space issue than a resource issue. Demolition is insufficiently documented and studied in New Zealand. Heritage of the built environment is narrowed to townscape precincts and heritage buildings preservation and does not refer to the protection of building products.

Involving stakeholders in encouraging the relevant sectors to the concept of reuse of building products would allow society to understand all the benefits of this activity. Sufficient resources and efforts have to be provided to ensure a strong and long-term involvement.

Therefore, **Recommendation Six** is to: involve stakeholders in encouraging the sectors relevant to the concept of reuse of building products.

In Dunedin, educating building professionals on sustainable building and on the practice to adopt could revolutionise this industry. Regarding C&D waste, the task undertaken by the DCC to get more accurate information on waste may highlight the significance of this waste stream. The DCC can also better emphasise its involvement in the Zero Waste programme and promote its waste exchange website. This may result in the DCC adopting C&D waste minimisation and management options. The DCC also has the opportunity to work with the NZHPT locally to develop an approach favourable to the salvaging and the reuse of heritage building products. This could involve a common approach to state
conditions required to salvage and reuse building products when a consent for the demolition of heritage building is granted.

In New Zealand, sustainable building could be better supported at a legislative level. Continuing professional development is a medium to raise the awareness of building professionals who are insufficiently aware of sustainable building. Efforts on C&D waste could be better supported at a national level if the government decided to make it a priority in solid waste management. However, more accurate figures on solid waste data will determine the future policies. Deconstruction could be promoted at a national level with the development of a scheme for demolition workers. Their continuing professional development could include education on good practice to salvage as much as possible, while ensuring health and safety. Regarding heritage, the NZHPT has the opportunity to review its approach to preservation and extend it to the protection of significant building products.

7.2. Conclusion

This thesis aimed to evaluate the feasibility of product reuse in the building industry and to present recommendations to extend this practice. It attempted to fill a gap in the literature by focusing on the reuse of building products, a cornerstone topic, at the edge of the themes of sustainable building, C&D waste, deconstruction, and heritage buildings. This research also identified legislative, social, cultural, and economic factors influencing this activity. It consequently means that this uncommon and commercial activity is a complex subject with many variables.

The findings of this study are that building products are reused mainly to maintain and renovate old buildings to maintain their style, illustrating that it is feasible to carry out this activity. This activity could be extended for heritage, environmental, and local economic development purposes although, currently, some factors prevent it happening. Finally, this research has established some recommendations through five main sectors to overcome these hindrances: research, education, economy, legislation, and leadership.

This study has demonstrated that research on many aspects of the reuse of building products is necessary to better understand how society values and carries out this activity. The development of incentives for a better reuse of building products should be another theme investigated more thoroughly to guarantee their benefits.
References


Dunedin City Council (2006) 'Dunedin City District Plan'.


Dunedin City Council (2010) *Dunedin Heritage Fund in Dunedin City Council (ed.), Dunedin: Dunedin City Council*.


Statistics New Zealand (2011b) Inforshare - Number and Value by Building Type, New Zealand Level (Annual-August), Wellington: Statistics New Zealand.


The Heritage Advisory Committee of Aurora (n.d.) Aurora's Architectural Salvage Program, Aurora: Aurora City Council.


**National Legislation Consulted**

Building Act 2004

Historic Places Act 1993

Local Government Act 2002

Resource Management Act 1991

Waste Minimisation Act 2008
Appendix A

Eindhoven’s Ladder

Appendix B

Contents of the LEED New Construction v2.2 and the BREEAM New Constructions for Non-Domestic Buildings

The contents of the LEED New Construction v2.2 and the BREEAM New Constructions for Non-Domestic Buildings are analysed in the next sections in light of the reuse of building products through the themes of solid waste management, deconstruction, and design for reuse. A brief presentation of the scope of these schemes is introduced beforehand, illustrating the arbitrary weighting of sustainable building performances.

Scope

The LEED New Construction v2.2
The LEED New Construction v2.2 evaluates a building’s sustainability through six categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process (United States Green Building Council, 2008). The building assessed under these conditions has to meet some prerequisites (which do not provide any point). It is given credits when it has other than minimal environmental characteristics (Haselbach, 2010). A total number of 69 points are available and a building is certified if it totals a minimum of 26 credits, or a minimum of about 38% of the total amount of points available.

The BREEAM New Constructions for Non-Domestic Buildings
The BREEAM 2011 New Constructions for Non-Domestic Buildings contains 49 environmental assessment issues, evaluated through nine categories: “management, health and well being, energy, transport, water, materials, waste, land use and ecology, and pollution” (BRE Global, Ltd, 2011, p. 28). Additional credits can be granted for innovation (BRE Global Ltd, 2011). This scheme is intended to be used for public buildings (such as
those related to education, healthcare, prisons, and law courts), multi-residential accommodation buildings, and a list of other non-domestic buildings. Some credits are granted according to the building’s occupancy, meaning that there is no fixed total number of points accredited with this method (BRE Global Ltd, 2011). A minimal compliance has to be met for some environmental assessment issues for the building to be accredited. A building is rated ‘pass’ when it totalises a minimum of 30% of the total score.

**Solid Waste Management and Reuse of Salvaged Products**

**The LEED-NC v2.2**

The LEED-NC programme rates buildings partially through their waste production during the construction stage only (as the end of life of a certified building is excluded from its scope) and through their materials reuse in the category ‘Materials and Resources’ (United States Green Building Council, 2008). Seven types of credits are available in this category; they are listed in the following table.

<table>
<thead>
<tr>
<th>Number of Credit</th>
<th>Title</th>
<th>Amount of Points Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit 1</td>
<td>Building Reuse</td>
<td>3</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Construction Waste Management</td>
<td>1</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Materials Reuse</td>
<td>2</td>
</tr>
<tr>
<td>Credit 4</td>
<td>Recycled Content</td>
<td>2</td>
</tr>
<tr>
<td>Credit 5</td>
<td>Regional Materials</td>
<td>2</td>
</tr>
<tr>
<td>Credit 6</td>
<td>Rapidly Renewable Resources</td>
<td>1</td>
</tr>
<tr>
<td>Credit 7</td>
<td>Certified Wood</td>
<td>1</td>
</tr>
</tbody>
</table>

The next paragraphs describe the LEED credits relevant to C&D waste production and the reuse of building products detailed. Credit 2 ‘Construction Waste Management’ aims to “divert construction, demolition and land-clearing debris from disposal in landfills and incinerators. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites” (United States Green Building Council, 2005, p. 47). Under this credit, the LEED advises the adoption of a waste management plan to divert at least 50 percent of non-hazardous waste during the construction stage. A
second point can be granted if a minimum of 75 percent of non-hazardous waste is diverted from landfill or incineration. The guide specifies that donating materials to charitable organisations or reusing on-site are forms of diversion.

Credit 3 ‘Materials Reuse’ aims to “reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources” (United States Green Building Council, 2005, p. 49). One credit can be attributed if the reused materials amount to at least 5% of the total cost of materials in the building. A second credit can be attributed if the percentage reaches 10%. It is worth noting that “mechanical, electrical and plumbing components and speciality items such as elevators and equipment” are excluded from this scope (United States Green Building Council, 2005, p. 49). An additional point can be granted in the ‘innovation in design’ category if the materials reuse amounts to 15% of the total cost of materials in the rated building (Haselbach, 2010).

Although, the reuse of materials is stipulated explicitly in the LEED-NC v2.2 programme, a maximum of 3 points are available for the reuse of materials in credit 3 and in the innovation in design, out of 69 points available, which means that the reuse of building materials accounts for about 4.3% of the total of points available to certify a building. Despite this low amount of points available for the reuse of building products, the increasing number of buildings being accredited through the LEED programme in North America has led the building industry to reconsider the value of salvaged building products (Gorgolewski and Morettin, 2009).

The BREEAM 2011 New Construction – Non-Domestic Buildings
The BREEAM 2011 New Construction – Non-Domestic Buildings has two categories for materials and waste. The reuse of building products is embedded within the ‘materials’ category. The environmental assessment issues for this category are listed in the following table:
Credits Available in the Materials and Waste Categories (BRE Global Ltd, 2011)

<table>
<thead>
<tr>
<th>Title</th>
<th>Amount of Points Available</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
<td></td>
</tr>
<tr>
<td>Mat 01 Life cycle impacts</td>
<td>Building type dependent</td>
</tr>
<tr>
<td>Mat 02 Hard landscaping and boundary</td>
<td>1</td>
</tr>
<tr>
<td>Mat 03 Responsible sourcing of materials</td>
<td>3</td>
</tr>
<tr>
<td>Mat 04 Insulation</td>
<td>2</td>
</tr>
<tr>
<td>Mat 05 Designing for robustness</td>
<td>1</td>
</tr>
<tr>
<td><strong>Waste</strong></td>
<td></td>
</tr>
<tr>
<td>Wst 01 Construction waste management</td>
<td>4</td>
</tr>
<tr>
<td>Wst 02 Recycled aggregates</td>
<td>1</td>
</tr>
<tr>
<td>Wst 03 Operational waste</td>
<td>1</td>
</tr>
<tr>
<td>Wst 04 Speculative floor and ceiling finishes</td>
<td>1</td>
</tr>
</tbody>
</table>

The next paragraphs detail the assessment issues related to the reuse of building products and which are listed in the table above. The assessment issue ‘Mat 01- Life cycle impacts’ aims to “to recognise and encourage the use of construction materials with a low environmental impact (including embodied carbon) over the full life cycle of the building” (BRE Global Ltd, 2011, p. 230). The building elements assessed for this issue are: external and internal walls, windows, roof, floor, finishes and coverings (BRE Global Ltd, 2011, p. 230). The number of credits granted for the use of new elements is based on findings compiled in a document called the *Green Guide* (BRE Global Ltd, 2011). However, the certification process becomes complicated if the elements used are salvaged. In this case, a BREEAM assessor has to apply for a ‘Bespoke Green Guide Query proforma’ to BRE Global for calculations and determination of the number of credits allocated (BRE Global Ltd, 2011, p. 233).

The assessment issue ‘Mat 03 – Responsible sourcing of materials’ aims to “recognise and encourage the specification of responsibly sourced materials for key building elements” (BRE Global Ltd, 2011, p. 248). Within the 2011 guide for the BREEAM, reused materials are granted a tier credit of ‘3’ but revisions might change this weight (BRE Global Ltd, 2011, p. 257). This tier credit is equivalent to a ‘very good’ certification level under the
‘BRE Global, BES6001 Product certification’, meaning that reused products are considered to be a relatively good responsible source of building products.

The assessment issue ‘Wst 01 – Construction waste management’ aims to “promote resource efficiency via the effective management and reduction of construction waste” (BRE Global Ltd, 2011, p. 274). Within ‘construction resource efficiency’, BREEAM advises an audit to take place to decrease the amount of construction waste landfilled. Within the scope of this issue, the diversion of resources is accredited one point. Diversion from landfill includes:

1. Reusing the material on site (in-situ or for new applications),
2. Reusing the material on other sites,
3. Salvaging or reclaiming the material for reuse,
4. Returning the material to the supplier via a ‘take-back’ scheme,
5. Recovery of the material from site by an approved waste management contractor and recycled or sent for energy recovery (BRE Global Ltd, 2011, p. 276).

One additional point is available for each of these assessment issues if the building has an ‘exemplary level of performance’, in the innovation category (BRE Global Ltd, 2011, p. 358).

Solid waste management, and in particular, materials and waste are criteria used to determine the sustainability of a building in the LEED NC v2.2 and the BREEAM New Construction for Non-Domestic Buildings. These rating tools acknowledge the C&D waste hierarchy indirectly, by advising the adoption of a plan to decrease the amount of construction waste landfilled. However, they miss specifying the need for such a plan to be adopted at the end of life of the certified building. The assessment tools also refer explicitly to the reuse of building products as a resource supply, demonstrating that this activity is sustainable, and consequently encouraging it. The next section introduces the lack of implementation of the concept of deconstruction in the two green building rating tools studied.

Deconstruction
The end of life of a building is excluded from the scope of LEED-NC v2.2 and from BREEAM 2011 New Construction, Non-Domestic buildings rating tools (BRE Global Ltd, 2011; United States Green Building Council, 2008). Therefore, they do not refer to
Deconstruction explicitly. The next section presents how the BREEAM and LEED rating tools weigh design for reuse.

**Design for Reuse**

**The LEED-NC v2.2**

Academics consider since the early 2000s design for deconstruction and other designs to value salvaged products after the alteration of a building (Crowther, 2001; Norton and Skates, 2000). However, no credit is currently explicitly available for it in the ‘materials and resources’ category of the LEED-NC v2.2 programme (Saleh and Chini, 2009; United States Green Building Council, 2008). However, up to five points are available for previously unrated environmental improvements among the other five environmental categories in the innovation and design process category (Haselbach, 2010).

Among these five points, four are available as exemplary performances in innovation in design, one point per innovation (United States Green Building Council, 2008). The aim of these credits is to:

> provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED for New Construction Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED for New Construction Green Building Rating System (Haselbach, 2010, p. 305).

The adoption of a design of reuse or similar is credited under the exemplary performance in innovation in design (Saleh and Chini, 2009). According to the information available, it seems that the adoption of design for reuse would allow a credit of one point under these conditions.

**The BREEAM 2011 New Construction – Non-Domestic Buildings**

The BREEAM NC – Non-Domestic Buildings guide does not mention any term referring to a design for material recovery. However, the assessment issue ‘Mat 05 – Designing for robustness’ aims to “recognise and encourage adequate protection of exposed elements of the building and landscape, therefore minimising the frequency of replacement and maximising materials”, which is supposed to help maintaining the quality of future salvageable building products (BRE Global Ltd, 2011, p. 272). Furthermore, credits for design for reuse can be granted under the ‘tenth category’ ‘innovation’, which provides up to 10 credits. One credit is allowable per individual assessment. The aim of this section is
to “support innovation within the construction industry through the recognition of sustainability related benefits which are not rewarded by standard BREEAM issues” (BRE Global Ltd, 2011, p. 358). An approved innovation has to be submitted by a licensed BREEAM assessor to BRE Global, who will consider it. This innovation category offers the opportunity to value one point design for reuse.

The indication of design for reuse is not explicit in the two most famous green building rating tools. However, this type of design can be considered in the innovation category of these tools. This demonstrates a gap between theory and practice in the building sector, where design for recovery, and reuse has been advocated for a long time by academics but is not explicitly accounted for in green building rating tools.

**The Outcomes of the Performance Choices to Implement Sustainable Building for the Reuse of Building Products**

The reuse of building products, if included in a green building rating tool, is attributed a certain amount of points or credits, not systematically reflecting the significance of the reduction of the building’s environmental impacts induced. Some academics think that the mention of criteria on the reuse of building products, or on deconstruction or on design for deconstruction in green building rating tools favour the recovery of building products and their reuse (Gorgolewski, 2011; Nakajima, 2011).

Saleh and Chini notably encourage a revision of green building rating tools, especially of the LEED programme for new construction, to give more credits to the reuse of building products and design for deconstruction: “what the industry needs is a new mental model that weighs the used construction materials as valuable resources worth harvesting in a manner that preserves their embodied energy and the CO₂ already invested in those materials” (2009, p. 29).
# Appendix C

## Key Informants Information

Table of Key Informants Interviewed

<table>
<thead>
<tr>
<th>Key Informant Number</th>
<th>Occupation or Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Informant 1</td>
<td>Self-employed Builder Dunedin</td>
</tr>
<tr>
<td>Key Informant 2</td>
<td>Building Consent Officer Dunedin City Council</td>
</tr>
<tr>
<td>Key Informant 3</td>
<td>Planner Dunedin City Council</td>
</tr>
<tr>
<td>Key Informant 4</td>
<td>Architect Dunedin</td>
</tr>
<tr>
<td>Key Informant 5</td>
<td>Heritage Planner Dunedin City Council</td>
</tr>
<tr>
<td>Key Informant 6</td>
<td>Solid Waste Manager Dunedin City Council</td>
</tr>
<tr>
<td>Key Informant 7</td>
<td>Architect Dunedin</td>
</tr>
<tr>
<td>Key Informant 8</td>
<td>Sustainable Development Professional Dunedin</td>
</tr>
<tr>
<td>Key Informant 9</td>
<td>Representative of Registered Master Builders Otago Association President</td>
</tr>
<tr>
<td>Key Informant 10</td>
<td>New Zealand Historic Places Trust representative Dunedin</td>
</tr>
<tr>
<td>Key Informant 11</td>
<td>New Zealand Historic Places Trust representative Dunedin</td>
</tr>
<tr>
<td>Key Informant 12</td>
<td>Developer Dunedin</td>
</tr>
<tr>
<td>Key Informant 13</td>
<td>Developer Dunedin</td>
</tr>
<tr>
<td>Key Informant 14</td>
<td>Senior Advisor on Building Standards Department of Building and Housing – Wellington</td>
</tr>
<tr>
<td>Key Informant 15</td>
<td>Researcher and Education Manager BCITO – Wellington</td>
</tr>
<tr>
<td>Key Informant 16</td>
<td>Education Manager BRANZ – Porirua</td>
</tr>
<tr>
<td>Key Informant 17</td>
<td>Demolition Manager Demolition Company – Dunedin</td>
</tr>
</tbody>
</table>
Appendix D

Information Sheet for Participants

Consent Form

Themes of Questions for Interviewees
Planning for the effective reuse of materials
in the New Zealand building industry

INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request. The information will be used solely for purposes of this research and your confidentiality will be maintained throughout the entire research process.

What is the aim of the project?

This project is being undertaken as part of the requirements for a Master of Planning degree (University of Otago). The project aims to analyse the incentives and hurdles influencing the reuse of materials in the New Zealand building industry. The study will focus on the Dunedin context, analyse factors of success for such an implementation and suggest recommendations to encourage a wider sustainable approach to buildings.

Who is participating?

You have been chosen according to your knowledge of the themes of waste management, and also your experience in the building industry. You may also have been selected following your knowledge of the Dunedin community.

It is anticipated that around fifteen to twenty people will be interviewed for this study.
What will you be asked to do?

Should you agree to take part in this project, you will be asked to answer a few questions as to your professional perception of the current trends in Dunedin regarding either waste management procedures or building techniques, and future trends. Also you might be asked questions about the practices of the community regarding the reuse of materials. The amount of time involved will vary depending on your discussions and may last up to one hour.

Please be aware that you may decide to withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

This project involves an open-questioning technique. The general line of questioning includes your perception of the current trends in Dunedin regarding either waste management procedures or building techniques and their future. Questions can also be related to the perceptions of the community towards sustainable design. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

What data or information will be collected and what use will be made of it?

Information about the current trends in solid waste management, building activity and regarding the perceptions of the community toward the possible application of materials in buildings will be collected. If you agree, the interview will be audio-taped and responses will be transcribed to be used in the thesis.

The tapes will be destroyed at the completion of the project. The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the
results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

**Will you have the opportunity to correct or withdraw the data/information?**

Clarification of information will be done with you before concluding the interview. However, you will be provided with the researcher’s contact details should you wish to discuss any issues raised in the process of data collection and correct or withdraw data.

**Will you be provided with the results of the study?**

You are most welcome to request a copy of the results of the project should you wish.

**What if you have any questions?**

If you have any questions about this project, either now or in the future, please feel free to contact either:-

Elodie Letendre and/or Rosalind Day
Department of Geography
03-479 4218
letel189@student.otago.ac.nz

Rosalind Day
Department of Geography
03-479 8780
rhd@geography.otago.ac.nz

This study has been approved by the Department stated above. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:
1. My participation in the project is entirely voluntary;
2. I am free to withdraw from the project at any time without any disadvantage;
3. I am aware of the nature and extent of my involvement in this research project and that the interview process will take approximately 20 minutes of my time;
4. Personal identifying information will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years after which it will be destroyed.
5. This project involves a semi-structured questioning technique, where although the questions have been arranged in advance, the interview will develop in an open-ended fashion based on the responses you give. In the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular question(s) and/or may withdraw from the project without any disadvantage of any kind.
6. There are no known or anticipated risks to participating in this study;
7. There is no remuneration for participating in this study;
8. The results of the project will not be published, and will be made available only to the researchers, the academic staff of the Department of Geography, University of Otago, and those participants that request a copy of the research. Every attempt will be made to preserve my anonymity if I choose to remain anonymous.
9. I grant/ do not grant * permission to allow the research audio record my interview
10. I grant/ do not grant * permission to allow the research to use my identity

*Please indicate by circling

I agree to take part in this project

........................................
(Signature of participant) date

........................................
(Signature of researcher, acknowledging receipt) date

This study has been approved by the Department of Geography. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Planning for the Effective Reuse of Materials in the New Zealand Building Industry

QUESTIONS / TOPICS FOR INTERVIEWEES

Questions may deviate from those listed above but will remain consistent with the central themes of research.

1. **WASTE**
   
   a. Generalities (Figures) and solid waste management practices
   
   b. Construction and deconstruction/demolition waste

   Have you implemented a waste management plan to deal with unused materials when you have finished your activity on site?
   
   Are you familiar with the notion of deconstruction?
   
   If yes, do you apply and promote it?

2. **REUSING MATERIALS**

   a. Is your organisation involved in the reuse of materials in the building industry? What is its role?

   b. How would you evaluate the reuse of materials in the building industry?

      i. Individuals renovating or building a house

      ii. A builder renovating or building a house

      iii. A major company renovating or building a complex.

   c. If you are deconstructing a building, what are the elements/materials which can be reused easily without any problems?

   d. What are the procedures that your organisation has to foresee before reusing materials?
i. Administrative / building consent

ii. Market and profitability

iii. Others.

e. Can you think of any advantages allowing for the reuse of materials? (such as quality of materials, cost, existing market, real estate market…)

f. Can you think of any hurdles preventing the reuse of materials? (such as transport of materials, absence of market, insurance, real estate market…)

g. How do you think the reuse of materials is going to evolve? (future trends)

h. Do you hear of complaints/submissions from the community?

i. According to your professional opinion, what could be done to encourage such a practice? (e.g. in the building application process, financial incentives, statutory and non-statutory approaches)

j. Can you think of any strengths and weaknesses in the implementation of incentives to reuse materials in the building industry in the Dunedin context?
Appendix E

Clauses B1 and B2 of the Building Code
### Clause B1—Structure

<table>
<thead>
<tr>
<th>Provisions</th>
<th>Limits on application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td></td>
</tr>
<tr>
<td><strong>B1.1</strong> The objective of this provision is to:</td>
<td></td>
</tr>
<tr>
<td>(a) safeguard people from injury caused by structural failure,</td>
<td></td>
</tr>
<tr>
<td>(b) safeguard people from loss of amenity caused by structural behaviour, and</td>
<td></td>
</tr>
<tr>
<td>(c) protect other property from physical damage caused by structural failure.</td>
<td></td>
</tr>
<tr>
<td><strong>Functional requirement</strong></td>
<td></td>
</tr>
<tr>
<td><strong>B1.2</strong> Buildings, building elements and sitework shall withstand the combination of loads that they are likely to experience during construction or alteration and throughout their lives.</td>
<td></td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td></td>
</tr>
<tr>
<td><strong>B1.3.1</strong> Buildings, building elements and sitework shall have a low probability of rupturing, becoming unstable, losing equilibrium, or collapsing during construction or alteration and throughout their lives.</td>
<td></td>
</tr>
</tbody>
</table>
### Provisions

**B1.3.2** Buildings, building elements and sitework shall have a low probability of causing loss of amenity through undue deformation, vibratory response, degradation, or other physical characteristics throughout their lives, or during construction or alteration when the building is in use.

**B1.3.3** Account shall be taken of all physical conditions likely to affect the stability of buildings, building elements and sitework, including:

- (a) self-weight,
- (b) imposed gravity loads arising from use,
- (c) temperature,
- (d) earth pressure,
- (e) water and other liquids,
- (f) earthquake,
- (g) snow,
- (h) wind,
- (i) fire,
- (j) impact,
- (k) explosion,
- (l) reversing or fluctuating effects,
- (m) differential movement,
- (n) vegetation,
- (o) adverse effects due to insufficient separation from other buildings,
- (p) influence of equipment, services, non-structural elements and contents,
- (q) time dependent effects including creep and shrinkage, and
- (r) removal of support.

### Limits on application
<table>
<thead>
<tr>
<th>Provisions</th>
<th>Limits on application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B1.3.4</strong> Due allowance shall be made for:</td>
<td></td>
</tr>
<tr>
<td>(a) the consequences of failure,</td>
<td></td>
</tr>
<tr>
<td>(b) the intended use of the building,</td>
<td></td>
</tr>
<tr>
<td>(c) effects of uncertainties resulting from construction activities, or the sequence in which construction activities occur,</td>
<td></td>
</tr>
<tr>
<td>(d) variation in the properties of materials and the characteristics of the site, and</td>
<td></td>
</tr>
<tr>
<td>(e) accuracy limitations inherent in the methods used to predict the stability of buildings.</td>
<td></td>
</tr>
<tr>
<td><strong>B1.3.5</strong> The demolition of buildings shall be carried out in a way that avoids the likelihood of premature collapse.</td>
<td></td>
</tr>
<tr>
<td><strong>B1.3.6</strong> Sitework, where necessary, shall be carried out to:</td>
<td></td>
</tr>
<tr>
<td>(a) provide stability for construction on the site, and</td>
<td></td>
</tr>
<tr>
<td>(b) avoid the likelihood of damage to other property.</td>
<td></td>
</tr>
<tr>
<td><strong>B1.3.7</strong> Any sitework and associated supports shall take account of the effects of:</td>
<td></td>
</tr>
<tr>
<td>(a) changes in ground water level,</td>
<td></td>
</tr>
<tr>
<td>(b) water, weather and vegetation, and</td>
<td></td>
</tr>
<tr>
<td>(c) ground loss and slumping.</td>
<td></td>
</tr>
</tbody>
</table>
Clause B2—Durability

Provisions | Limits on application
---|---

**Objective**

**B2.1** The objective of this provision is to ensure that a building will throughout its life continue to satisfy the other objectives of this code.

**Functional requirement**

**B2.2** Building materials, components and construction methods shall be sufficiently durable to ensure that the building, without reconstruction or major renovation, satisfies the other functional requirements of this code throughout the life of the building.

**Performance**

**B2.3** [Revoked]

**B2.3.1** Building elements must, with only normal maintenance, continue to satisfy the performance requirements of this code for the lesser of the specified intended life of the building, if stated, or:

(a) the life of the building, being not less than 50 years, if:

(i) those building elements (including floors, walls, and fixings) provide structural stability to the building, or

(ii) those building elements are dif-

Performance B2.3.1 applies from the time of issue of the applicable code compliance certificate. Building elements are not required to satisfy a durability performance which exceeds the specified intended life of the building.
<table>
<thead>
<tr>
<th>Provisions</th>
<th>Limits on application</th>
</tr>
</thead>
<tbody>
<tr>
<td>(iii) Failure of those building elements to comply with the building code would go undetected during both normal use and maintenance of the building.</td>
<td></td>
</tr>
<tr>
<td>(b) 15 years if:</td>
<td></td>
</tr>
<tr>
<td>(i) those building elements (including the building envelope, exposed plumbing in the subfloor space, and in-built chimneys and flues) are moderately difficult to access or replace, or</td>
<td></td>
</tr>
<tr>
<td>(ii) Failure of those building elements to comply with the building code would go undetected during normal use of the building, but would be easily detected during normal maintenance.</td>
<td></td>
</tr>
<tr>
<td>(c) 5 years if:</td>
<td></td>
</tr>
<tr>
<td>(i) the building elements (including services, linings, renewable protective coatings,</td>
<td></td>
</tr>
<tr>
<td>Provisions</td>
<td>Limits on application</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>and fixtures) are easy to access and replace, and</td>
<td></td>
</tr>
<tr>
<td>(ii) failure of those building elements to comply with the building code</td>
<td></td>
</tr>
<tr>
<td>would be easily detected during normal use of the building.</td>
<td></td>
</tr>
</tbody>
</table>

**B2.3.2** Individual building elements which are components of a building system and are difficult to access or replace must either:

(a) all have the same durability, or

(b) be installed in a manner that permits the replacement of building elements of lesser durability without removing building elements that have greater durability and are not specifically designed for removal and replacement.

