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Identifying Barriers to Reducing Ontario's Construction Waste Through Reclamation, Reuse, and Recycling

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IDENTIFYING BARRIERS TO REDUCING ONTARIO'S CONSTRUCTION WASTE
THROUGH RECLAMATION, REUSE, AND RECYCLING

by

Joseph Martin Earle,
Bachelor of Humanities,
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2007

A thesis

Presented to Ryerson University
in partial fulfillment of the
requirements for the degree of
Master of Applied Science
in the Program of
Building Science

Toronto, Ontario, Canada, 2013

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Author's declaration for electronic submission of a thesis

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Abstract

Identifying barriers to reducing Ontario's construction waste through reclamation, reuse, and recycling

Master of Applied Science, 2013, Joseph Martin Earle, Building Science, Ryerson University

Construction, renovation, and demolition waste contributes at least one quarter of all waste that is destined to landfill and incineration in Canada. This research hypothesized that residential renovations could play a significant role in decreasing the amount of waste through reuse of used building materials. It therefore sought to identify barriers to recycling, reclamation, and reuse of building materials in the Ontario construction, renovation, and demolition industry. Through a mixed-method survey of green building professionals five primary barriers were discovered. With greater leadership from green building professionals, materials and markets becoming more consistently available, and more buy-in from residential contractors and homeowners conducting renovations these barriers can be overcome and this type of project can help contribute to reduction of construction, renovation, and demolition waste in the province.

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Finally, thank you to my beautiful and tolerant wife, Julie. You are an amazing human being who provides me with perspective as to what actually matters with your dedication to making people's lives better every day of yours. You are my greatest supporter and the best friend anyone could ever ask for.

Dedication

This thesis is dedicated to my best friends, Julie and Timaeus.

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List of Abbreviations

<i>Word or Phrase</i>	<i>Abbreviation</i>
Reclamation, reuse, and recycling	RRR
Construction, renovation and demolition	CRD
Used building material	UBM
Habitat for Humanity	HFH
Industrial, commercial and institutional	ICI

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1. Introduction

Sustainable construction must account for many factors from the durability and quality of the final product to the requirements of occupants and the environmental impacts of a project. Further investigation must take account of the materials and associated waste that is produced during construction projects in Ontario. Ultimately waste from construction activities affects all Canadians as they pay for municipal waste services and construction materials take up large amounts of space in a decreasing number of landfills. In Ontario, there are few commercial construction and renovation companies who manage waste with reclamation, reuse and recycling (RRR) in mind. On the residential scale there are even fewer. An analysis of the wasting of valuable materials is required for Ontario in order to understand methods for reducing waste and the barriers that prevent this from happening at this time.

To achieve sustainable buildings the impacts of the materials used in a building and methods for constructing, utilising and managing resources throughout a building's life including repairs, renovations, and demolitions must be considered (Sobotka & Wyatt, 1998). Waste is created in the production, transportation, installation, use, maintenance, and ultimately the removal or demolition of built components. Sustainable construction, renovation, and demolition (CRD) sites use materials and products that have "low ecological impacts, pose no or low human and environmental health risks, and assist with sustainable strategies" (Calkins, 2009). They also minimize waste through material recycling and reuse, by reducing waste on building sites, and optimizing the use of finite resources (Kibert, 2008; Sobotka & Wyatt, 1998). Deconstruction of buildings in a planned and controlled manner in order to produce an assortment of reusable building materials and components is relatively well understood as far as process required and practices to make it happen. However, the continued use of these components and materials in

other buildings or in alternate functions is much less well known and rarely studied (Thomsen, Schultmann & Kohler, 2011). The reclamation and subsequent reuse and recycling of construction materials will be the focus of this study in order to determine if solutions exist to reduce waste and thus contribute to continued sustainable development of the built environment.

2. Literature Review

2.1. Key Terms and Definitions

Key terms and definitions that are used throughout the thesis are defined in Table 1.

Table 1: Definitions of key terms related to resource reuse.

Adapted from Calkins (2009) p 79.

Term	Definition
Reclaimed material	Material set aside from the waste stream for future reuse with minimal processing
Reuse	The use of reclaimed materials for their original purpose or related purposes
Reprocessed materials	Materials that are broken down or size reduced from their unit or standard size. Although often down-cycled, reprocessing materials uses less energy and produces fewer emissions than remanufacturing for recycling
Construction, renovation and demolition waste	Materials resulting from the construction, remodelling, repair, or demolition of buildings, bridges, pavements and other structures
Recycled content materials	Materials or products that have some or all component parts that have undergone processing to create new products.

2.2. Defining the Problem of Construction, Renovation, and Demolition Waste

The management of CRD waste is increasingly recognized as a major issue facing the construction industry all around the world. On every CRD job site there is waste generated every day by a variety of trades and for a variety of reasons. The waste generated on each job site is unique in its composition but primarily is comprised of a few main materials such as drywall, wood, metals, concrete and packaging materials like cardboard (Roper, 2006; United States Environmental Protection Agency (EPA), 2003; Recycling Council of Ontario (RCO), 2006). The volume and composition of these wastes varies by country and region as do traditional building materials and techniques. The management of wastes on construction, renovation and demolition job sites has improved in many places around the world in recent years but is still far from perfect. The following section discusses what CRD waste is, where and how CRD wastes

are generated on job sites, how waste is currently managed on Ontario CRD sites, and the impacts of material use and waste created by the construction industry has on the environment.

CRD waste needs to be understood in terms of what materials it is typically composed of, where it originates and how it is measured. Roper (2006) cites the “many uncertainties surrounding actual accurate accounts” of CRD waste as contributing confusion about the problem and difficulty in comparing and understanding data. CRD waste commonly refers to a large number of materials that are generated as waste on new construction, renovation, and demolition projects and sometimes includes land clearing waste and infrastructure projects. According to Statistics Canada (2000) CRD waste is defined as waste materials produced in the process of construction, renovation or demolition of structures, which include buildings of all types (both residential and non-residential) as well as roads and bridges. CRD waste has also been defined in many other ways ranging from the very simple “residential building-related waste” (RCO, 2006) to the more complex

“... wastes generated by construction, renovation and demolition activities. It generally includes materials such as wood, drywall, certain metals, cardboard, doors, windows, wiring, etc. It excludes materials from land-clearing on areas not previously developed, as well as materials such as asphalt, concrete, bricks and clean sand or gravel” (Statistics Canada, 2010).

The various definitions of CRD wastes mean that accurate accounts of the volume and material composition of this waste can vary dramatically. Wastes are typically analysed in terms of either the total weight of waste or the volume of CRD waste as a percentage of the total solid waste created or destined for disposal or recovery. There have been very few studies conducted in the recent past that calculate the type and volume of waste that is generated within construction industry (Yeheyis, Hewage, Alam, Eskicioglu, & Sadiq, 2013). The most recent CRD specific study conducted in Ontario was the Recycling Council of Ontario’s 2006 report

Let's Climb Another Molehill that was produced in 2006. With much of the data that is available being nearly a decade old and with changes to policies, regulations and the composition of materials themselves, the actual volume, weight, and composition of the waste may be different than the currently available statistics.

Differences in the amount of waste from construction activities can arise from differences in building traditions and differences in geography/geology, but the economic activity within the sector will also influence waste generation (Fischer & Werge, 2009). In the USA, building construction, renovation and demolition creates 164 million tons (149 million metric tonnes) of waste per year representing between 25-40 % of all solid waste (Winkler, 2010). Eight hundred and fifty million tons per year are generated by the construction activities of the European Union (EU) member states, accounting for 31% of total waste generated (Fischer & Werge, 2009). Zhao, Leefink and Rotter (2010) note that in developing countries the statistics are quite similar with CRD waste accounting for 30-40% of total waste production. In Canada, it has been estimated that from 9-11 million tonnes of CRD waste are generated every year, amounting to 25-33% of all solid waste that is destined for landfill (Statistics Canada, 2000; RCO, 2006; Yeheyis et al., 2013). Examples of the variation that do exist within the Canadian statistics include a study prepared for the Alberta Construction, Renovation, and Demolition (CRD) Waste Advisory Committee in 2000 that measured wastes entering public and private landfills estimated that between 17-21 % of waste in Alberta is CRD related (C2HM Gore and Storrie Limited, 2000). A study conducted for Natural Resources Canada used this Alberta study and the biennial Statistics Canada *Government and Business Waste Management Industry Survey* as a baseline to estimate the percentages of individual waste materials. Using both a regional and

mathematical method they estimated that between 2,828,000 and 4,758,000 tonnes of CRD waste is generated each year in Canada (Sinclair, 2006).

The main materials comprising both residential and non-residential waste are quite common across all studies. In Ontario, wood, concrete, brick and other masonry make up greater than 60% of residential and 80% of non-residential demolition waste according to the Recycling Council of Ontario (2006). Common components of CRD waste include concrete, asphalt pavement, mixed rubble, brick, wood, metals, gypsum wallboard, floor tile, cardboard, plastics, and roofing materials (Calkins, 2009; Roper, 2006; US EPA, 2003; CH2M, 2000; Sandler, 2003). Although the percentages of each type of waste vary based on each study, the materials are relatively homogeneous hinting that solutions need only be developed for a select number of materials to greatly reduce the overall waste destined for landfill or other undesirable fates.

Having defined what CRD waste is and understanding its typical composition, it must be asked which sector this waste originates from, what construction activities produces wastes, and what factors affect waste generation on job sites. There are significant differences in the wastes originating from residential and non-residential construction sectors. The relative proportion by weight of CRD wastes generated from residential vs. non-residential activities is 43% and 57% respectively (Franklin Associates, 1998). Table 2 shows the splits for Canadian residential and non-residential CRD waste materials based on different construction activities as per a recent study conducted for Natural Resources Canada (Sinclair, 2006). Renovation activities account for 55% of waste in residential construction activities and 36% of non-residential CRD wastes. Demolition activities create 58% of non-residential wastes and 34% of residential wastes. New construction is only a small percentage of both residential (11%) and non-residential (6%) CRD waste.

Table 2: CRD Splits for Residential & Non-Residential Waste Materials (Sinclair, 2006)

Activities	Residential	Non-Residential
New Construction	11%	6%
Renovation	55%	36%
Demolition	34%	58%

A USA Environmental Protection Agency (EPA) study suggests similar results showing that by activity, new construction generates 8%, renovation 44% and demolition 48% of the CRD waste by weight (Franklin Associates, 1998). Also in line with the Natural Resources Canada statistics, Agamuthu (2008) suggests that renovation and demolition activities can account for 90% of nations CRD waste. According to the Recycling Council of Ontario (2006), demolition projects can create 20 to 30 times as much waste as new construction projects. Conflicting data from an Alberta study conducted over one summer showed that waste originated 64% from new construction, 28% from renovations, and 8% from demolitions (CH2M, 2000). This study seems to have been heavily influenced by a nearby urban area with large amounts of new construction contributing waste to the surveyed landfills. As an example of the potential influence this may have had on the results the researchers pointed to of the rural sites unaffected by these new subdivisions where 32% of waste was from new construction, 41% from renovations, and 27% from demolitions (C2HM, 2000). This study demonstrates that the economic activities of a region will have a significant impact on the types and volumes of wastes that are created. It also suggests that a survey of landfills may not be the most accurate way to assess the flow of materials from CRD activities because this type of survey is very dependent on the activities at the time and regionally specific to the research.

Across all construction activities and in both residential and non-residential sectors there are several factors that are commonly cited for waste being created. The most common factors cited include design errors, changes in design during the construction stage, excessive ordering with planned wastage rates, improper procurement and planning, inefficient material handling and construction (Ilozor, 2009; Roaf, 2004; Poon, 2007; Yeheyis et al., 2013). All of these problems arise from the human factor that is present in all CRD activities but has rarely been studied through qualitative research in Ontario. Problems with design process can contribute major portions of waste to a construction or renovation project. Not designing for the use of standard sized materials is essentially designing waste into the construction process. If designers used standards that matched available materials then these wastes could be avoided (Poon, 2007). Last minute design changes can result in major portions of already constructed products being dismantled and disposed of unnecessarily and redoing of work already completed (Ilozor, 2009; Yeheyis et al., 2013). More detailed designs and client involvement throughout the process would allow for less reworking of projects on the go resulting in waste production (Poon, 2007).

Excessive ordering of materials can lead to leftover materials, storage issues and damaged materials (Ilozor, 2009). Having excess materials can also lead to careless construction practices because of perception of “extra” material available to complete a given project. Planning for waste is common in materials management by construction professionals and leads to irresponsible attitude of all involved from procurement to finished product. Poon (2007) observes that 10% of construction waste is generated from cutting of building materials during construction. The amount of waste generated from construction activities on site can be as high as 15% of all materials procured for a project (Roper, 2006). Excessive transportation and

movement of materials can contribute to waste and having leftover materials can result in new, perfectly good materials being disposed of at the end of a job (Ilozar, 2009; Yeheyis et al., 2013).

Finally, Winkler (2010) notes that recycling and reduction of waste is not only the responsibility of on-site contractors, "...building material manufacturers and architects must contribute to creating spaces that are more recyclable." This means that planning and design professionals need to be considering the problems of waste from the earliest stages of a project. Ilozar (2009) notes the selection of inexpensive or inappropriate materials can lead to greater waste production in both the short and long term. The selection of materials that are durable and of sufficient quality to last to the greatest possible extent will limit the waste created during a building's life.

Construction renovation and demolition wastes are managed in much the same way as other solid wastes. There are policies and regulations governing how they are handled, where they are stored and sometimes have requirements dictating required levels of diversion. The EU Waste Framework Directive has a requirement that 70% of each member state's C&D waste be reused or recycled by 2020 (BIO Intelligence Service, 2011). Ontario's Environmental Protection Act regulation 102/94 dictates that a waste audit is conducted and a waste reduction plan are implemented by builders or property owners before construction begins (Environmental Protection Act, 1994a). Ontario Regulation 103/94 states that source separation programs be implemented for waste generated at construction and demolition projects. In particular brick concrete, cardboard, drywall, steel and uncontaminated wood must be separated on construction and demolition projects. The source separation program is supposed to be implemented before any construction activities begin (Environmental Protection Act, 1994b). The Ontario regulations apply only to large construction and demolition projects, those over 2000 square meters. This

means that a very large proportion of CRD projects are not governed by these regulations, in particular no residential projects. Even with regulations in place enforcement of policies always seems to be an issue, and in 2007 a renewed emphasis was placed on enforcing the Ontario guidelines (Yeheyis et al., 2013). One common criticism of current regulations in many countries is that they set minimum standards rather than encouraging maximum environmental performance (Crawford, 2011).

Even with existing regulations in place CRD waste still ends up in both landfills and incinerators. More than 75% of CRD waste in the USA is sent to landfills and incinerators (Winkler, 2010). In Canada 35% of total municipal solid waste placed in landfills originates from CRD sources (CCA, 2001) and it has been reported that only between 12-16 % of CRD wastes are currently being recycled (RIS International Ltd., 2005). These waste rates are particularly disturbing because recycling and reuse opportunities do exist. Studies have shown that a massive amount, from 45-75%, of CRD waste material has the potential to be recycled or reused meaning there is large room for improvement in our current waste management practices (Nobe, 2007; Shami, 2006). Winkler (2010) suggests that as much as 95% of all waste on construction and demolition sites can be recycled. Knowing that the potential for reclamation is so high and yet such enormous amounts of waste are being generated in Ontario demonstrates a need for research into the reasons why this continues to occur and what are the barriers to making CRD waste reduction happen in the province.

All of the news is not bad; countries such as Germany, Denmark, Ireland, the Netherlands and the United Kingdom have recycling rates which are higher than 70% (BIO Intelligence Service, 2011). As of 1996 from 20-30% of US C&D waste was reused or recycled (Franklin Associates, 1998). Calkins (2009) notes that although more recent data is not available this figure

has probably increased due to increases in tipping fees, a decreasing number of landfills, and reuse and recycling markets that have developed over the past decade. For all of Canada more than 700,000 tonnes of CRD waste was diverted from landfill as of 2008, Ontario lead the way with 209,628 tonnes diverted (Stats Canada, 2010). A major part of the problem is that the easiest and quickest option for a demolition contractor is to demolish the building and deal with the materials as quickly as possible. If a market for a specific product does exist these contractors will sell the materials in order to make as much money as quickly as possible (Addis, 2007). However, if no local markets exist then these valuable materials are often disposed of just as quickly. The same can be said for general contractors or builders running new construction or renovation projects. If a market does not exist or they are unaware of such markets then more than likely the costs of disposal in landfill are passed along to the client and the contractors will send materials directly to landfill or transfer stations. Demolition contractors stand to gain substantial revenue with the further development of a market for reused and recycled materials that they may have already been contributing to for a long time. With increased demand for products more demolition projects will carefully and efficiently remove materials from job sites and take them to UBM suppliers. Until the time that such a market exists wastes will take the path of least resistance and lowest cost which unfortunately at this time remains landfilling.

Globally the construction industry is recognized to consume massive amounts of resources and materials, more than any other industry (Horvath, 2004). Building materials account for 30-50% by volume of all manufactured goods, excluding food production (Roaf, 2004). In Canada, buildings and their construction and maintenance consume 50% of natural resources used, account for 25% of landfill waste, and produce 35% of greenhouse gases (The Sheltair Group, 2008). The impacts created by construction activities go far beyond the project

itself because construction materials are comprised of a variety of resources and cause waste from their production, transportation, during their use within a project, and finally at the end of their life when they are removed or disposed of. The industry's use of materials has been connected to global climate change, raw material depletion, fossil fuel depletion, loss of biodiversity, air pollution, and water resource depletion (Calkins, 2009).

As with most consumer products, market prices for construction materials do not reflect the true costs they inflict upon the environment from beginning to end of their lifecycle (Roper, 2006). These missing externalized costs and the environmental impacts of materials are a powerful reason why attempts should be made to recycle and reclaim more materials from CRD projects. This would not only extend the life of the individual building components but greatly limit the impacts of creating and processing virgin resources. Because materials need to be considered at all stages of this lifecycle, life cycle assessment (LCA) is becoming increasingly common for many materials and building projects (Crawford, 2011). The four main ecological impacts to consider are; the energy and water used in these products, the toxicity in production, use and disposal, the waste implications relating to disposal and landfilling, and the use of finite resources (Roaf, 2004). Understanding these implications improves awareness of problems of buildings and the waste generated within their production, maintenance, and end of life. This problem affects us all through costs and impacts to the environment but also more simply in every Canadian's wallet. In 2008, \$2.6 billion was spent by local governments on waste management and the national average was \$79 per person spent on waste management (Statistics Canada, 2010). With CRD waste making up such a large portion of all solid waste generated and managed by these facilities it clearly costs all Canadians regardless of whether they participate in a CRD project in any given year.

Improving the markets of reclamation for recycling and reuse of construction materials in Ontario would have significant impacts on the total amount of CRD waste destined for landfill and incineration. Current markets for reclaimed materials can be quite disparate and volatile depending on both supply and the demand for certain materials. Some of the time a contractor may get a good price for a material and then the next time they encounter this material they may have to pay to have it removed (Addis, 2007). The use of local and reused building components have been said to reduce construction and demolition waste by up to 90% (The Sheltair Group, 2008). Because there is a lack of comprehensive data on the markets that exist in Ontario this research will attempt to fill that gap. By encouraging the growth of reclamation markets in Ontario the impacts of CRD waste on the lives of Ontarians and the local environment could be drastically diminished.

2.3. Reducing Construction, Renovation and Demolition Waste

Many solutions have already witnessed success regarding the reduction of waste from the CRD industry. By adhering to the waste management hierarchy and choosing alternatives to traditional mechanical demolition, large amounts of waste can be diverted from landfill. Alternatives to demolition such as selective or complete deconstruction, adaptive reuse of existing buildings and future planning, such as design for deconstruction, result in UBMs becoming more readily available. The waste management hierarchy encourages reduction of materials used and the reuse of those that still have life. However, in order for these efforts to actually contribute to the reduction of CRD waste there must be demand for UBMs. If no such markets exist in a given region, either in terms of demand for materials or retail locations where materials can be exchanged, then the materials that are harvested from CRD projects will have

no place to go but to landfill or incineration. This research will identify materials that are easily and commonly reclaimed in Ontario to understand whether there is more that can be done and if lessons can be learned from CRD waste reduction strategies that have witnessed success elsewhere.

The phrase “reduce, reuse, recycle” is ubiquitous in Canada but most often recycling is the only step that people adhere to. This phrase originates in the waste management hierarchy, shown in Figure 1, and is used by governments, industry (including Canada’s construction industry) and individuals to encourage best practice in waste management.

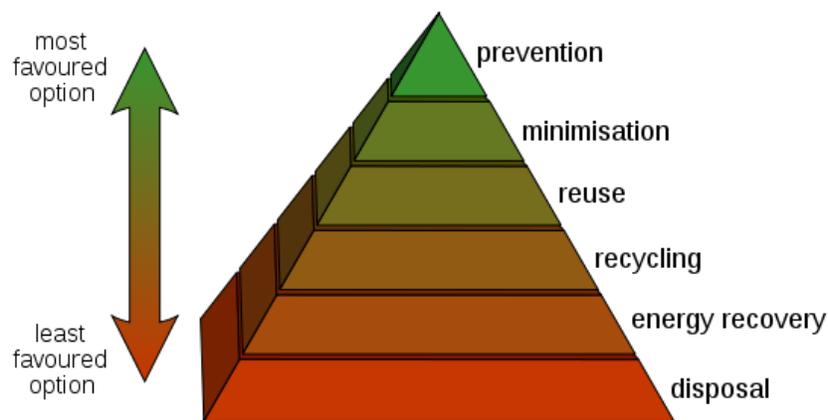


Figure 1: The Waste Management Hierarchy
(Source: http://en.wikipedia.org/wiki/File:Waste_hierarchy.svg)

The waste management hierarchy consists of a basic plan for minimizing and ultimately eliminating waste. From a basic reduction in the volume of materials and products that we consume, to reusing and recycling materials and products that are still valuable the hierarchy is used for all sorts of waste management plans for institutions, communities and industries. The waste management hierarchy demonstrates various “shades of green” with the most desirable option starting at reduction of materials used in the first place. For example reducing waste by reusing materials in place or “as is” would be more desirable than recycling a material into a new

product. Although some steps are bigger than others, all shades of green are a step in the right direction towards sustainable materials usage on construction sites (Calkins, 2009).

Deconstruction and adaptive reuse are alternatives to traditional mechanical demolition that are born from the waste management hierarchy and the understanding that existing materials have an inherent value. Adaptive reuse involves reusing the entire building for an alternative purpose with changes mostly occurring to the interior of the structure in order to make the facility work with the new function it has been given. This is an example of reduction or avoidance on the waste management hierarchy. Deconstruction instead of demolition involves either selectively or entirely dismantling a building in order to harvest valuable materials. The Canadian Standards Association has put out documents on both of these topics in recent years, first the *Guideline for Design for Disassembly and Adaptability of Buildings (2006)* and then *Deconstruction of Buildings and their Related Parts (2012)*. These are guidelines for improving demolition and renovation practices in building projects and in doing so will encourage more reclamation, reuse, and recycling of building materials.

A pre-emptive alternative to demolition is design for deconstruction. This involves the careful planning of what goes into a building and how it is put together with the intention that at the end of the buildings life materials can easily and readily be harvested. Going forward, design for deconstruction will help the market for reused goods and recycled materials to develop more rapidly in the future (Addis, 2007). By simply paying attention or planning dimensions of materials to be used to standardized product sizes, major savings can be made in the amount of waste produced (Winkler, 2010). In new construction and renovation projects, by selecting materials that will themselves be able to be recycled at the end of their initial service life the future impacts on resources can be decreased (Calkins, 2009). Certain materials have high

recyclability such as wood, concrete, and asphalt, while other are not at all possible to recycle such as composite materials which are a comingled material. Solutions include waste minimization by design, component replacement within assemblies, through prefabrication of components in a controlled environment offsite, or by not releasing defective or incomplete products into the process (Ilozor, 2009). Contractors generally include a certain waste percentage as a margin of error in material ordering. Winkler (2010) suggests only working with material suppliers who are willing to take back full or portions of materials they have delivered to the job site in an effort to help minimize waste.

While many solutions do exist that can contribute to waste reduction, material reuse, and recycling materials are still ending up at the bottom of the waste management hierarchy at landfills or as fuel for incineration. Improving the RRR of materials in construction and renovation faces many challenges. Existing research has identified some common barriers and problems associated with the reclamation, reuse and recycling of CRD materials on both the supply and demand side of the economic equation (Calkins, 2009; Winkler, 2010; Crawford, 2011). These include a lack of knowledge, markets not being locally available, costs, time, difficulty, lack of incentives and a lack of willingness to participate in reclamation activities. These barriers vary depending on local conditions including local labour costs and regulations and construction activities. This research will seek to find whether these identified barriers are the same problems that affect the Ontario regions and whether any unique challenges exist.

Perceptions regarding costs, time, aesthetics, and difficulty contribute to a lack of willingness by some construction professionals and consumers to reuse products and materials. Because the decisions behind a project are made primarily by the client or consumer they must be on board with sustainable objectives, such as appropriate waste management practices, in

order for a project to succeed in meeting waste management goals (Crawford, 2011). Angelil & Siress, (2010) stress that a paradigm shift must take place in terms of understanding the impacts of CRD activities on resources in order to change the desire of the community at large. Because many residential renovations are undertaken with the quick sale or flip of the home in mind there must be some sort of incentive to make developers and homeowners willing to better manage waste associated with a project (Crawford, 2011).

The actual economic costs of CRD projects are always a key factor in all phases of a project. In the construction and demolition industry labour and time are the key cost factors (Munroe, Hatamiya, & Westwind, 2006). As for individual company's they are more concerned with surviving and making a profit in the ultra-competitive CRD industry:

“Their prime consideration is profitability and survival. This attitude makes sense. They are not concerned about various externalities (positive and negative) that are inherent in deconstruction projects. In other words we have a situation of market failure. The market mechanism does not take into account effects such as pollution, socio-economic impacts, traffic congestion and resource conservation among others” (Munroe, Hatamiya, & Westwind, 2006).

Munroe, Hatamiya, and Westwind (2006) go on to state that the time needed to deconstruct a building is longer than traditional demolition. Due to limited timeframes of demolition projects, combined with a lack of incentives to minimize waste time and costs associated with it are used as excuses for not properly managing wastes or harvesting materials from CRD sites (Green Leigh & Patterson, 2006).

Costs are described as one of the main deterrents from conducting deconstruction versus traditional demolition projects. However in many cases selling reclaimed materials supports the activity of deconstruction (Green Leigh & Patterson, 2006). Also, if a developer is going to sell a

property immediately after renovating then the incentive to include long term financial savings through sustainable features or practices is limited (Crawford, 2011).

The existence of markets for UBMs and recycling opportunities within a community greatly contribute to the amount of materials that are reclaimed or salvaged in the local CRD industry. A lack of available markets for the materials created during the CRD process is a major barrier to waste reduction (Green Leigh & Patterson, 2006). Without the presence of facilities to which materials can be delivered for proper handling, contractors locally will be limited in the waste management services that they can offer. In rural areas markets for recycling and reuse may not exist (Winkler, 2010). Ontario has vast areas where there are very few opportunities for waste management to be properly enacted. In northern communities the recycling and reuse options may be hundreds of kilometers away which makes it unfeasible to expect this to happen (van de Merwe, 2009). Companies do not want to spend massive amounts transporting wastes and due to the competitive nature of the business they would potentially lose out on jobs if they attempted to pass on high transport or other associated costs on to customers. The development or presence of markets would be the paradigm shift that is needed (Angelil & Siress, 2010). A robust UBMs market would constitute the economic structure and raise awareness merely by its presence in communities (Kraumanis, 2005). Retailers selling UBM's in "as is" condition will greatly enhance the potential of reuse within communities. However, markets can only exist if there are both willing buyers and sellers of materials and therefore the existence of markets is determined by participation of local communities in terms of both supplying and consuming materials. Limited quantities and lack of consistent availability of quality materials is a barrier to greater reclamation, reuse and recycling in CRD projects (Winkler, 2010). Hence, this research

will seek to identify whether there is enough participation on both sides of the economic equation in Ontario at this time.

To overcome many barriers surrounding CRD waste there need to be educational and awareness campaigns about how to make deconstruction work and about available markets for excess and waste materials created during CRD projects (Green Leigh & Patterson, 2006). Based on current education models and theories, some research suggests that young design and construction professionals are ill equipped to handle “the historic complexity of the built environment” (Kohler, 2002). Knowledge of markets, how to salvage, and possibilities for reusing and recycling materials in projects is generally lacking and implementing source reduction is often complicated by the fact that much of the design and construction community is just beginning to recognise that it has a role in creating source-reduction solutions (Roper, 2006). Deconstruction and other alternative solutions may be dismissed as unviable options because salvaging materials may be misunderstood and existing attitudes and lack of awareness may prevent those involved from pursuing alternatives to traditional demolition.

Addis (2007) suggests that the greatest barriers to reuse of materials is not only unfamiliarity with the markets but also inertia, by which he means that the construction industry has always done things a certain way and getting those involved to change their ways is a significant challenge. This is basically a problem with attitudes of CRD professionals and consumers due to a lack of understanding of opportunities. It has been suggested that rather than looking at the pile of old materials as a problem, it should be considered as a great resource, which can lead to the development and implementation of sustainable materials in construction (Kraumanis, 2005; Yeheyis, Hewage, Alam, Eskicioglu, & Sadiq, 2013). Knowledge also needs to be raised in consumers because decisions are made by those with the greatest amount at stake

in a project, usually the building owner or investors, and without them on board sustainable objectives will be hard to obtain (Crawford, 2011).

Various challenges have been identified in the existing literature in terms of the difficulty with using and handling reclaimed and recycled materials. The most commonly listed difficulties include the contamination of recyclable or reusable materials with toxic or other materials, the need for creativity in reusing certain materials, storage of materials and meeting the requirements of all interested parties from government to industry and consumers. During demolition many materials are commonly contaminated with paint and wall coverings, adhesives, and other wastes (Falk & McKeever, 2004). This makes material recovery for recycling and reuse difficult. Many salvage industries already exist however materials are often not in finished form, meaning that they require the curiosity, creativity and persistence to make them work in new and unique ways (Gang, 2010). Green Leigh and Patterson (2006) list the main barriers to deconstruction as handling and storage of materials, limited timeframes of demolition projects, and an inability to reuse materials in the current form. For market introduction of reclaimed materials there are many barriers that need to be overcome such as certification of materials and meeting the requirements of all interested parties from government, to suppliers and consumers of products (van Eijk & Brouwers, 2009). UBM suppliers often have to deal with a negative image of their products and contractors using UBMs will have to deal with liability concerns (van Eijk & Brouwers, 2009). It has been suggested that certification of materials in order to meet the requirements of all interested parties, from government to suppliers and consumers of products, will have a positive impact on materials reuse and recycling (Munroe, Hatamiya, and Westwind 2006; van Eijk & Brouwers,2009).

2.4. The Need for a Robust Salvaged, Reused and Recycled Materials Market

There is much to be done in order to make RRR markets into a reality that can make real impacts on the amount of CRD waste sent to landfill. Current design and construction practices can significantly influence these markets both now and in the future. The markets for reclaimed and recycled materials and building products in the future will be influenced by how we design and construct today (Addis, 2007). Construction waste reduction should be considered at an early stage and by all parties involved in the building process (Poon, 2007). ‘Cradle to cradle’ and ‘zero waste’ are impressive ideas, however they lack effectiveness so long as it is cheaper to landfill than to reduce, reuse, and recycle and the true externalized costs of waste production are not recognized (Angelil & Sireess, 2010). Several authors have proposed rethinking how we procure our materials in terms of simple metaphors. Gang (2010) uses the metaphors of a cook using local ingredients, a prospector mining the urban environment for resources, and a nomad who wants simple and reusable materials when describing the ideal reuse and recycling focused construction team. Tolla & Lignano (2010) provide an elegant description of a butcher carefully dissecting an animal as a comparison to how they deconstruct a building and value the materials:

“Like a skillful butcher, who respects the precious complexity and subtlety of the animal he is dissecting, we try to find an economy and a sustainability in how we cut and combine, to find way to facilitate eating ‘the whole pig’; from nose to tail, with no waste and with surprisingly recombinant recipes.” p 297

Thinking outside of the traditional design and construction realms provides ideas and inspirations for how we think about materials. It can reshape how CRD professionals and consumers seek materials for projects. It can add a level of excitement and interest to the finished

product when the story of where a material has come from is known. This requires a shift in aesthetics and an appreciation in the value and previous lives of materials.

Improving the way buildings and their associated materials and by-products are managed can have significant impacts on social, environmental and economic performance of communities (The Sheltair Group, 2008). Replacing primary construction materials with secondary materials could save natural resources and contribute to a sustainable society (van Eijk & Brouwers, 2009). With changing dynamics of populations and growing challenges in different international markets the problem of supply and demand of recycled and salvaged construction materials is only going to grow in the next 30-50 years (Hiete, Stengel, Ludwig, Schultmann, 2011). Given the impact of construction, renovation, and demolition (CRD) waste on the environment, efforts must be made in order to reduce the amount of waste through every stage of a building's lifecycle and one important method is by reintroducing waste materials into the supply chain (Crawford, 2011). Ontario should strive to be at the leading edge of this wave of reclamation and reuse. In order to do this there needs to be research into identifying the barriers that currently prevent this from happening.

A classic definition of economics is that it is “the study of scarce resources which have alternative uses” (Sowell, 2007). When materials are sent to landfill they are presumed to be useless and are rendered as such. The alternative uses for many construction materials can come in many forms from recycling and repurposing into new products and/or reuse in an as is condition. Under this understanding of economics reusing building materials becomes more an issue of making all involved parties aware of the intrinsic value of the materials they are wantonly disposing. There also needs to be a viable alternative for materials other than landfill. We know that CRD materials are composed of increasingly scarce resources, the challenge

becomes creating alternative uses and thriving markets for them. A robust reuse and recycling market for used construction materials would contribute to sustainable development within Ontario by lowering environmental impacts caused by resource extraction, manufacturing and disposal, as well as saving costs versus new materials and those related to handling of waste. In developing countries nothing is thrown away that can be used again, but in the richer countries there is a surprising growth in the market for demolition waste (Roaf, 2004). Winkler (2010) notes that “despite significant growth in the recycling industry in the past ten years, more recycling markets are needed to enable contractors to consistently market their C&D waste.” Reuse operations provide an essential link between waste generators and consumers of materials that would otherwise end up in landfill. However, in order for this market to take up the use of these materials on a more frequent basis there needs to be a regular contribution of high quality materials to this market and a presence in terms of companies and organizations across the province who sell UBMs. There needs to be the creation of one stop shop businesses for deconstruction, dealing with materials from demolition site to marketing and selling of materials (Green Leigh & Patterson, 2006). Builders can improve the markets for recycled goods by purchasing materials themselves, “the formula is simple: the more recycled products contractors and consumers purchase, the greater the market for recycled waste” (Winkler, 2010). Alternate solutions have also been proposed in terms of incentives to business and how governments can impact the situation. Meeting the challenges and barriers requires a collective effort by all interested parties. Besides imposing high waste management fees, governments may also implement other incentives to promote the wider use of waste reduction measures in construction projects (Poon, 2007).

It has been recognized that improving the way buildings and materials used in their construction and maintenance are managed can have significant influence on social, environmental and economic development of communities (The Sheltair Group, 2008). Reuse of components and adaptive reuse of entire buildings instead of the wasteful process of demolition and reconstruction is considered superior to new construction in terms of reaching sustainability goals (Bullen, 2007; Calkins, 2009; Kohler & Hassler 2002). Winkler (2010) lists cost savings, the opportunities for job creation and energy savings from the procurement, production and transportation of materials as the top reasons for recycling and reuse of C&D materials. By reusing materials in 'as is' condition or reprocessing materials on site, costs can be saved on both energy and transportation of wastes. The only environmental impacts of doing this are the energy used in transporting and reworking a product (Calkins, 2009). An Australian study analysed the potential cost and embodied energy savings of a residential home being constructed using second-hand or recycled materials compared to new. The results of the analysis based on actual costs of second hand materials and estimated embodied energy savings found that cost savings could reach 40% of the building price, and achieve a 70% reduction in embodied energy (Treloar, Gupta, Love, & Nguyen, 2003). Another study compared two cases of a building, one using all new material content and one using a large portion of recycled and second hand materials, found that a 55% reduction in environmental impacts could be achieved through the use of recycled and UBMs (Thormark, 2000). Of course, the proportions and type of natural resources that are saved by recycling building materials vary considerably with the building material that is recycled or reused (Thormark).

The residential renovation market presents a unique opportunity for the reuse of CRD waste materials. Kernan et al (2001) suggest that the residential renovation sector is particularly

well suited to foster the growth of the reused and recycled building materials markets because of the small size of most renovation projects, and the smaller quantities of materials are required. Individual projects can witness real savings on material costs and project impacts can be minimized with locally sourced content. However, individual homeowners will only demand UBMs if they are aware of the potential that they have and Addis (2007) suggests that the best way to stimulate the markets for UBMs is through providing concrete examples of their use in successful projects. Unfortunately no research has yet been conducted to identify whether the residential renovation markets in Ontario are well suited to this purpose.

A robust market for UBMs can only exist if there is strong awareness and willingness to use such products within a region and if it meets the requirements of both suppliers and consumers of products. The suppliers require a certain level of assurance that the products they are consistently selling to make money for their business will be available in the required quantities and of a specific quality. Consumers want to know that the purchase and use of reused and salvaged building components will not lead to a project requiring sooner than usual levels of maintenance or repair. The feasibility of deconstruction methods versus mechanical demolition and landfilling is dependent on local labour costs and productivity in removing valuable products from CRD projects, waste disposal rates and the existence of a market for these materials (Dantata, Touran & Wang, 2005). The residential renovation sector can act as a means to grow this market and decrease the CRD waste destined for landfill and incineration because of the significant amount of materials this market purchases collectively but requires many barriers to be overcome for this to happen. The residential renovation markets already have a significant impact on the Ontario economy and with a push towards the use of recycled and reclaimed

materials it can contribute significantly towards the environmental and societal goals of sustainable development as well.

2.5. Summary of Literature Review

- There is a recognized problem with CRD waste and there is not much up to date literature about the situation in Ontario
- Many waste reduction strategies have found success around the world however little has been identified in terms of what is specifically being done in Ontario
- There has been no research conducted in Ontario that seeks the opinions of leading green building professionals about how they and their companies handle waste. In particular, the human component of waste creation has received little attention in the existing literature.
- Although many barriers to waste reduction have been identified in international literature there is very little in terms of Ontario regional focus
- It has been proposed that residential renovations provide a viable opportunity for reducing CRD waste through reuse of components within these projects.

3. Methodology

3.1. Statement of the Problem

The literature review demonstrates that there are significant gaps in the literature regarding CRD waste in Ontario. Much of the information is dated and although many barriers to waste reduction have been identified in international research there is no specific research within this region. There have also been many studies that attempt to quantify the physical waste that is disposed of, yet few exist that account for the human factors of attitudes, awareness, and the choice of whether or not to participate in waste reduction strategies. For this reason a mixed methods approach was chosen, consisting of both qualitative and quantitative surveys, as the best method for analysing the current CRD waste situation in Ontario.

The purpose of this study is to identify the issues affecting the CRD waste management in the province of Ontario. Through an analysis of opinions of leading green building professionals in Ontario and the current situation surrounding waste management on CRD sites, the research will attempt to identify barriers and existing solutions to the recycling, reuse, and reclamation (RRR) of CRD waste materials throughout the process of the materials waste flow chain. There is very little research specific to CRD waste flows in Ontario and a need exists to understand the waste management process and the potential markets for these valuable waste materials in this region. This research intends to show that opportunities exist in residential renovations to provide for the use of reclaimed construction materials and to contribute to an overall reduction in the amount of CRD waste that is disposed of in Ontario.

Objectives:

The research will address the following objectives

1. Identify markets for recycling, reclamation and reuse of CRD materials in Ontario

2. Identify materials commonly reclaimed, recycled and reused within CRD activities and what materials show room for improvement?
3. Identify attitudes, awareness and degrees of participation of leading green building professionals in Ontario regarding the use of UBM markets.
4. Based on the previous three objectives identify common barriers to the use of recycled and reclaimed CRD materials in residential renovation projects.

3.2. Methodology Development

To achieve these objectives multiple approaches were undertaken.. A thorough literature review was conducted in order to provide a framework and background to the research. From there, the methodology consisted of a mixed methods survey containing both a qualitative and quantitative approaches. The qualitative portion sought the detailed opinions of a small number of key informants while the quantitative portion was distributed on wider scale to provide a broader baseline from within the CRD industry. Both approaches were deemed necessary as they were ultimately designed to complement one another in terms of scope and depth in order to provide a sufficient level of validity to the overall findings of the research. The surveys were developed in accordance with established qualitative and quantitative survey research methods through utilizing several resources to ensure appropriate validity and rigour (Bernard, 1994; Denzin & Lincoln, 2008; Seale, 2008). Surveys were tested for length, quality and clarity of questions with several members of the construction industry prior to distribution. In order to ensure that all the rights of survey participants were accounted for and protected the research team undertook and achieved all requirements under Ryerson Research Ethics Board for research involving human participants. Approval was granted for Research Ethics Board file REB 2012-364 on January 14th, 2013 for a one year period. These surveys sought perspective on the

markets for UBMs in Ontario, on a broad scale through a brief questionnaire and through more in depth discussions with key industry informants in the green building sector.

3.3. Mixed Method Survey

A two part mixed-methods survey in the form of structured interview and twenty Likert scale questions were created in order to get an in-depth review of those participating or involved with the RRR materials markets in Ontario. Both qualitative and quantitative methods were deemed necessary in order to provide greater overall validity to the findings of the research. The in-depth interviews provided specific opinions and observations of key informants within the green building industry. The Likert scale surveys were intended to provide a broad overview of the opinions and practices of a larger number of individuals who work within the construction and waste management industries. The focus was placed on understanding the attitudes, awareness, and participation of self-identified “green” building and waste management professionals regarding the use of reclaimed and recycled content building materials in projects across Ontario. Common themes were sought within the interview data which, when compared with the data from the Likert survey data, provided a more accurate picture of the state of how the CRD industry in Ontario deals with and feels about waste. In line with the hypothesis of this research, professionals were asked about the potential of residential renovations as a means of reducing CRD waste where previous research and publications have suggested that UBMs markets can best be grown. The Likert scale survey was designed to collect broad basic data based on the opinions of a large number of green building professionals against which the more detailed interview data will be compared. The surveys collected no personal identifying data and were collected anonymously. These 20 question surveys were created with the intention of garnering a broad perspective of sustainable and green building professionals and those involved

with CRD waste management regarding their attitudes, awareness, and level of personal and professional participation in reusing, reclaiming and recycling building materials. The format involved asking participants to state their level of agreement to a statement on the following five point scale; strongly agree, agree, neutral, disagree, and strongly disagree. The complete Likert scale survey is attached as Appendix A.

The Likert scale surveys were distributed at a Toronto Zero Waste Conference hosted by the Construction Resource Initiative Council in April 2013. Attendees represented construction and waste management companies and organizations from across Ontario with a vested interest in waste reduction on construction renovation and demolition sites. Surveys were also distributed by email and via the Canada Green Building Council monthly newsletter. Because of the population targeted for the Likert surveys the results will not be representative of the Ontario CRD industry as a whole. Instead they were meant to garner opinion from the leading edge in terms of sustainable construction and alternative waste management practices. In accordance with Ryerson Ethics Review Board requirements surveys were collected anonymously through the use of a discreet drop box location at in-person events. For digital copies participants clicked a submit button in the file and the surveys were anonymously and directly sent to the Ryerson Google Drive folder of the primary researcher.

Structured interviews of green building industry leaders were used as a means of gathering detailed information regarding how CRD waste is handled in Ontario and the best uses for reclaimed and recycled materials. Participants were asked for information regarding four main categories, their personal role/involvement with reused and recycled materials; their company's role/involvement with reused and recycled materials and how they manage CRD waste; the materials they encounter most often and feel are most likely to be reused and recycled;

and their opinions on the existing markets for UBM (UBMs), barriers to its expansion, and the future potential of such markets. Structured interviews were targeted to last from 30-60 minutes with several main questions but also follow-up questions which allowed the researcher to have the participants extrapolate on certain key areas in which they may have expertise or experience. The format used a standardized survey protocol (attached as Appendix B) for all of the survey participants to allow for exact replication of the interview format. Participants were guaranteed confidentiality and informed of their rights through a standard form created during the Research Ethics Board review process and their identities were known to the interviewer.

The research was deliberately targeted for participants with a self-identified interest in sustainable construction and responsible waste management. This was done in order to limit the scope of the work and to identify what the leading edge CRD professionals were doing within the province. This limits the possibility of generalizing the results to the broad CRD populations and potentially skews the results in favour of more positive approaches, attitudes and awareness towards waste management. The target populations for the mixed method survey research were any company, person or organization involved in the creation, reuse, recycling, or reclamation of CRD waste materials in Ontario. This included those involved in the procurement, collection, delivery, sales, adaptation, or creation of CRD waste products. Potential participants were identified through an internet search of companies operating within this sector and key members of the companies were identified and contacted via email with details of the research and information about participation. From this population, qualitative data in the form of structured interviews was sought and quantitative data in the form of Likert scale surveys were distributed. The qualitative surveys sought from 10-15 participants considered key informants on how CRD waste is handled in the province of Ontario. The quantitative questionnaires were distributed at

the Construction Resource Initiatives Council conference focused on setting targets of zero waste in the construction industry by 2030 and through the Canada Green Building Council (CAGBC) monthly newsletter that is distributed digitally to all members. Emails were also distributed to alternative and sustainable building professionals across the province that included a link to the survey. The parties contacted through these means were considered key informants because they held important leadership positions within their companies.

Structured interview data was collected by a combination of both written recording of responses and, if permission was granted by the participant, an audio recording of responses. This was done in order to provide the most comprehensive data from the interviews allowing for repeated review of the responses, as well as present opportunities for detailed coding and theme development after the interviews have been completed. Recorded data was transcribed within a fixed timeframe, agreed upon during the Research Ethics Board Review process, and audio files were then destroyed to ensure confidentiality. Interviews were conducted from January to April 2013 both in person and via telephone. Interview data was analysed using *Nvivo* 8 software. This is leading edge qualitative data analysis software used for coding of qualitative research data with a specific focus on streamlining the process of data collection, sorting, and analysis.

The Likert scale surveys were distributed on a wider scale, in both hard copy and digital formats. The digital surveys remained completely anonymous through forms designed with and delivered to Google Drive. Anonymous drop box locations were used at the conference and an automated survey response form that was attached as a link to all contact emails to ensure confidentiality of respondents. Information was collected digitally and in hard copies and input into IBM SPSS 20 data analysis software. The information from the two data sets was analysed for themes, compared against each other and with previously existing research. Similarities and

differences regarding recycled, reused and reclaimed CRD waste materials were sought with a particular focus on providing new and as yet unknown data on Ontario construction waste management and materials reuse and recycling processes.

4. Results

4.1. Likert Scale Survey Results

An estimated 300 people had access to the surveys from January to April 2013 and a total of 64 completed surveys were returned. This represents a 21.3% return rate. The following section provides an analysis of the results found within the survey responses. Complete Likert scale survey results and discussion of individual questions can be found within Appendix C.

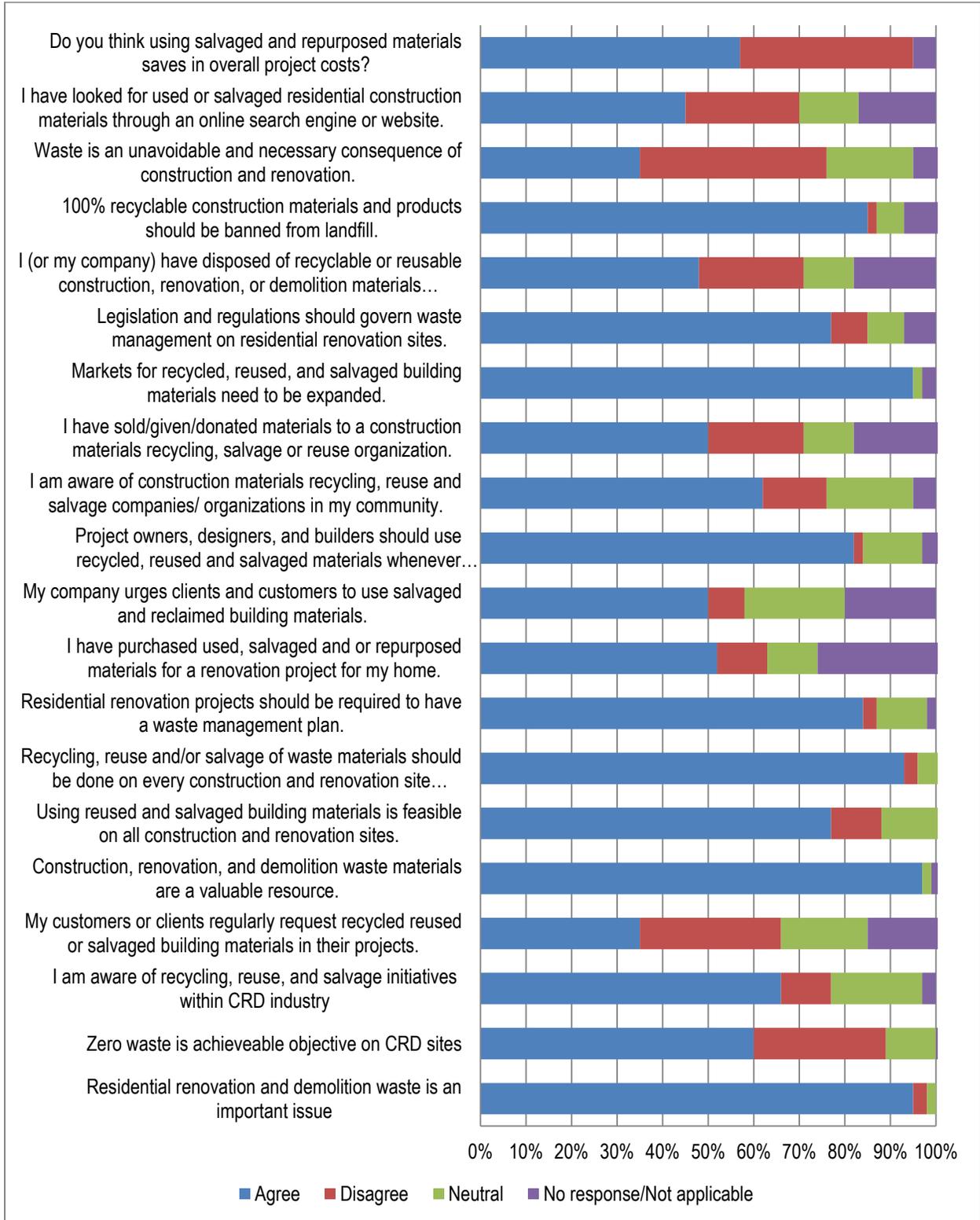
Participants came from several different professions and worked within a variety of industries. The largest identified professions were architect/designers (22%), carpenter/contractor (14%), materials sales/retail/marketing (13%) and construction consultants (11%). A large number (16%) of participants chose not to identify their profession. The remaining participants who chose to identify their profession came from a variety of fields, from university professors and government employees to engineers and estimators.

When asked to identify the industry in which they worked the majority (68%) of participants identified the following five industries, construction – industrial, commercial, and institutional (19%), construction – residential (17%), architecture (13%), materials/sales/architectural salvage (11%) and waste management (8%). The remaining participants identified a range of industries from community based non-profits and government, to building science and property management. 14% of respondents chose not to specify their industry.

Figure 2 shows the total percentage of participants who agreed and those who disagreed to the questionnaire statements. For simplicity, within Figure 2 and in order to understand binary levels of agreement or disagreement to the questionnaire statements, responses of agree or strongly agree were added and responses of disagree or strongly disagree were added. Survey

questions addressed a variety of issues around construction waste in order to assess the awareness of waste issues, attitudes about how waste is handled, whether individuals and companies were participating in waste reduction strategies and the markets for these reclaimed materials in Ontario. The following provides a summary of the results as they pertain to each of the research objectives. Through analysis of the cumulative results from the questionnaires, conclusions were made about the main barriers that face the CRD industry regarding waste management and reduction.

Figure 2: Percentage of Responses to Likert Scale Survey Questions
 (Due to rounding figures may not total 100%)



4.1.1. Attitudes, Awareness and Participation

The Likert survey showed that two thirds of respondents were aware of both initiatives within the CRD industry to reduce waste through recycling and salvage efforts and of organizations that are in the business of recycling, salvage, and reuse of materials. It is surprising that a third of participants are unaware of initiatives within industry and organizations that recycle, salvage and reuse materials given the population selected for the research included mainly green building and waste management professionals. Because it was nearly unanimous amongst respondents that waste management is an important issue and that CRD waste is a valuable resource the respondents clearly understand the significance of waste, the potential that exists within waste reduction and its impacts on the environment. This potentially shows that a lack of awareness may not be simply a problem of lack of knowledge. It is possible and quite probable that there are no initiatives going on in the CRD industry in certain regions of the province and that some regions of the province may be lacking in terms of recycling and reuse facilities and organizations.

It was surprising that nearly half of respondents claimed to have taken part in the disposal of materials they knew to be recyclable or reusable because they did not know what to do with them. This result presents a negative image that can be portrayed as lack of concern for impacts of waste and may demonstrate a lack of willingness to put in the effort in order to do the right thing at the expense of additional time or costs.

Regarding the attitudes of those surveyed it can be seen that green building and waste management professionals recognize the problems and potential of CRD wastes. As previously stated, questionnaire respondents were nearly unanimous in agreeing that CRD wastes are a valuable resource and that better management of wastes is an important and feasible issue. 93%

of participants also agreed that recycling, reuse and salvage should take place on projects of every size and nearly 85% thought that UBMs should be used whenever possible by designers, builders and project owners. Nearly two thirds of respondents went even further, agreeing that zero waste from CRD sites is an achievable objective. Clearly there is an understanding of the scope of the problem regarding CRD wastes and with the recognition of the value and importance of managing wastes it can be inferred that these professionals believe there are viable markets for recycling and reuse that exist to achieve these goals.

In terms of both personal and professional participation in the markets for recycled, and reclaimed materials results were mixed. Half of respondents had participated in the markets as both consumers and/or suppliers of reclaimed or used materials in their private lives. However, professionally only half of respondents worked for companies that encouraged the use of recycled and reclaimed materials. Even fewer, one third of respondents, had encountered regular requests from clients for these types of materials. With 93% agreeing that RRR should be done on every size of project, the respondents should use their personal experiences as a tool to lead by example. If the leaders of this industry had more personal experience with these materials and were willing to share their successes in the professional environment the subsequent challenges and successes of their use may seem less daunting to a sceptical client or co-workers.

4.1.2. Materials and Markets

More than forty percent of respondents believed waste was avoidable and unnecessary consequence of construction and renovation activities. This implies that they believe viable alternatives to traditional waste management practices exist. In fact, the majority of respondents also believed that landfill bans should be imposed on 100% recyclable materials, demonstrating that they were open to regulations to avoid business as usual practices that contribute to waste

generation. With half of respondents disposing of recyclable and reusable materials because they did not know what to do with them there is obviously still much that the industry needs to learn in terms of materials that can be salvaged and how it can and should be done. It was interesting to learn that 58% of respondents believed that using salvaged building components saved in project costs and yet they were not recommending these materials to their clients.

Awareness of local markets for recycled and reclaimed materials was high amongst respondents but because it was not unanimous it shows there are definitely gaps in the markets that need to be filled in Ontario. Respondents agree, almost unanimously supporting the idea that the markets for recycled and salvaged materials need to be expanded. This expansion can be done by a variety of means and nearly half of respondents had used internet resources as a means of searching for used materials. More than three quarters of respondents supported more regulations for construction waste for sectors that are not already covered by legislation. With growth in these areas and increased awareness and participation in the personal renovations projects of green building professionals the knowledge base could grow quickly. Success in small renovation projects could breed greater participation and ever increasing awareness which could filter into larger projects that they are participating in professionally.

4.1.3. Barriers Emerging from Likert Scale Surveys

Through analysis of the questionnaire results discussed above, several barriers that face the CRD industry regarding waste management emerged. The questionnaire results clearly show there is an understanding of the value and potential of improving CRD waste management in Ontario amongst leading edge professionals. The following barriers were identified: leadership, knowledge of material reuse, lack of awareness of RRR opportunities, and market participation. First, although those participating in the research demonstrated leadership in their private lives in

the use of reclaimed materials, this needs to transfer to the professional environment. Second, knowledge of what to do with recyclable and reusable materials once they are reclaimed from a project need to be grown. This can be done through spreading greater awareness of RRR opportunities and actions that already exist within the province. Finally, once individuals and companies are aware and knowledgeable, they need to participate in the markets as both suppliers and consumers of products. The survey results indicate that there is a lack of markets across the province and this limits participation. Further development of markets will in turn create increased knowledge and awareness, participation in RRR of UBMs and leadership across the industry. Without taking the knowledge and awareness and turning it into action nothing will change. However, with each successful project using reclaimed materials and waste reduction strategies more and more it becomes a regular way of doing business.

4.2. Survey Interview Results

Interviews were requested with 42 individuals who played key roles within companies who focus sustainable construction and waste management practices, of those contacted 13 agreed to be interviewed (31% response rate). All interview participants agreed to have the interviews recorded which aided in data analysis. Interview participants included:

- UBM retail store owners and managers,
- owner/operators of small residential construction companies,
- sustainability consultants,
- managers for large construction firms,
- recycling facility operators,
- alternative building specialists,
- and representatives from large waste management organizations.

Education levels of these key informants ranged from high school and training in the trades to post graduate education. Education backgrounds included engineering, architecture, law, sociology, and general arts degrees. The individuals who participated in the interviews worked for wide variety of companies that provided a range of services in the construction industry. Through the interviews, respondents provided their opinions on the state of CRD waste management and available markets for RRR activities for CRD materials in Ontario. They were asked to discuss the attitudes regarding waste, the awareness of alternatives to traditional waste management and procuring of materials, and their personal and professional participation in the RRR markets. Participants were also asked to identify barriers to reducing Ontario's CRD waste through use of salvaged and recycled products in low-rise residential renovations.

4.2.1. State of the Markets/Industry

In order to understand the barriers that exist to reducing CRD waste through RRR of building materials the interviews sought to understand the current state of the markets in Ontario.

The key points

- Habitat for Humanity network of ReStores is largest reuse retailer operating in the province
- There are a small number of private reuse retailers and architectural salvage stores operating in the province
- There is one operational CRD recycling facility with another slated to open late 2012
- There are growing number of websites that provide opportunities to connect used material suppliers with consumers

Four interviewees indicated that Habitat for Humanity (HFH) and their network of ReStores is by far the largest organization operating within the province that focuses primarily on the resale of UBMs. These interviewees indicated that the organization relies primarily on donations of materials from the public and private businesses and use the proceeds from the ReStores to pay the operational costs for the organization. This means that all cash donations to the parent organization can be used directly for the construction of affordable housing which is their primary mandate. More than half of interviewees indicated that there are also a small number of independent retailers in the province that provide a variety of services relating to UBMs. The main categories include for profit UBM retailers, salvaged wood companies that focus on recovering wood from barns, demolitions, and renovations, and businesses that turn waste materials into value added products such as furniture, household, and decorative items.

These same interviewees discussed that there are two large UBM yards in southern Ontario that are operated by major demolition contractors. Both are several acres in size and they sell direct to the public, through online advertising, and through word of mouth amongst CRD professionals. These yards tend to have large commercial, industrial, and institutional building components and materials that have been removed from demolition projects undertaken by the company. Many demolition companies offer some items for sale through their websites and there are many traditional scrap yards that readily accept construction metals but are much less likely to recycle, salvage, or sell any other construction materials. Interviews suggest that there are fewer than 10 architectural salvage businesses operating within the province. These companies focus primarily on older materials and the decorative and interior finishing materials that one interview respondent described as “the jewelry of a home”.

One respondent represented a CRD waste recycling facility that currently handles and recycles roughly 400 tonnes of CRD waste per day, it is currently the only CRD waste recycling facility of its kind in Ontario. However, three respondents indicated that Waste Management, a large publically traded company, was reportedly developing a facility in Toronto scheduled to open in late 2012 (Waste Management, 2012). One interviewee estimated that Ontario could probably support about 6 such facilities without any problem. There are also independent facilities that recycle individual CRD materials such as carpet and drywall in the Toronto area.

A strong majority of interviewees indicated that the internet offers increasing opportunities for connecting CRD industry and consumers with UBMs. Websites such as Leftover.ca and ontariogreenspec.ca were referred to by interviewees as specifically focused on used CRD materials markets. There is also the informal marketplace where individuals can sell

used and excess building materials online through websites such as Kijiji.ca and Craigslist.ca. Both of these websites have classified sections dedicated to UBMs or renovation materials.

4.2.2. Participation in Markets

- Majority of interview participants had used a wide variety of UBMs in personal renovation projects
- Salvaged materials originated from a wide variety of sources including CRD job sites, garbage bins, and both professional and personal renovation and demolition projects
- Majority of interview participants had contributed materials to recycling facilities, or reuse retailers
- Companies play a variety of roles in in the UBM markets
- Innovations regarding waste are happening and include simple solutions such as placing multiple bins on job sites, using UBMs to produce value added products, and procuring recycled and reclaimed materials
- It is rare for CRD companies to purchase or keep materials based on speculation for a future use.

The majority of interviewees, 11 of 13, had used RRR materials within their own home renovations. These 11 had used many types of materials including a variety of wood products, electrical fixtures, lighting, cladding, asphalt shingles, slate and stone, flooring products, and windows. The majority of these materials they had salvaged themselves from CRD job sites, garbage bins, and both professional and personal renovation and demolition projects. Less than half of interviewees had purchased these materials from UBM retailers.

Materials were reused in both traditional and non-traditional ways. Cladding and shingles were typically reused on garden sheds and other exterior projects. Decorative or repurposed items were used “as is” to add the finishing touches to a project. Dimensional lumber was often used for framing elements and other wood products were often repurposed into items such as shelving, gates and fences. One respondent had gone a step further, milling wood products into flooring and cladding, “...in my own house, I have milled sheathing boards into flooring and repurposed other sheathing boards into cladding. We also milled former structural joists into flooring.” Flooring was also the end result of salvaged slate chalkboards from an Ontario university. The respondent “salvaged and used them as flooring in my great room.”

Interviewees were asked if they had personally given, donated, or sold CRD materials to RRR companies of which 11 of 13 respondents said yes. The majority of respondents had given or donated materials to the HFH network of ReStores if one was locally available. Different interviewees had also sold materials to “an architectural salvage place” and to companies “who are obviously recycling metals.”

All of the interviewees described several roles and innovations that they have witnessed or their companies have undertaken in the management of wastes and materials in order to separate themselves from the majority of CRD professionals and companies in Ontario. The innovations and roles they discussed can be categorized as project management, salvage and deconstruction, and the use of reclaimed materials.

Project management innovations do not need to be extreme to make a company stand out in terms of waste management and reduction. Often, how a company manages the materials used and the wastes they generate on a job site differentiates them in the marketplace. Five interviewees indicated that something as simple as placing multiple bins on-site and asking

contractors, subcontractors and workers to sort wastes into the appropriate bins can make a substantial difference. Further, two interviews also indicated that choosing an appropriate waste transfer facility to deliver wastes to can mean the difference from a 40-60% to an 85-95 % recycling rate. Six interviewees discussed several contracting companies who track the amount of waste that they generate on each job site in order to both improve their own performance with waste and to inform clients as to how much waste is generated during the course of the project. These included both small residential renovation companies and large ICI contractors.

Project management innovations can also include materials procurement. According to a majority of interviewees, companies that conducted deconstruction or salvage activities on behalf of clients or themselves for future jobs were considered innovative and unique in Ontario. Four interviewees indicated that there are a limited number of companies that salvage and buy materials on speculation of finding a future use for these products. The primary reason these interviewees indicated that the number of companies that salvage materials is limited is because it would be an entirely different business from the CRD businesses that are currently running. Ultimately companies cannot afford the time, effort, and the associated challenges that come along the storage, transportation, and costs of managing these materials. Additionally these interviewees cited the costs of storage and tying up capital in materials that they may never be able to use as particularly difficult reasons why they did not buy materials on speculation. It was also indicated that a knowledge gap may have prevented deconstruction and salvage from happening more frequently and overcoming the above listed barriers.

A few of the interviews indicated that there are some companies that innovate by deliberately using salvaged materials as a way to differentiate themselves in the marketplace. Most often companies will reuse materials and components 'in situ' (in place) as a way of

reducing waste. It is interesting to note that seven interviewees indicated that once materials are on site the costs of installation are the same as with all new materials. Two interviewees who represented sustainable project management and consulting companies say that salvage and reuse is simply a part of the service they provide to customers and they treat every project as an educational opportunity for all involved. If reusable components are available that meet project requirements then they educate clients on opportunities and recommend reuse wherever possible. This has helped them save large amounts of money on materials and components for various projects they have consulted on. It is important to note that these savings included all costs associated with salvaging materials.

Finally, some innovation comes in terms of the ideas that companies present to clients. Simply discussing the ideas of alternative waste management and materials procurement was considered innovative for the larger general contractors and there are consultants who pride themselves on bringing the conversation to the table. Three interviewees stated that it may not result in better practices adopted for the particular job they are consulting on however, the conversation is an important first step in promoting any future change.

4.2.3. Attitudes and Awareness of Markets for Reuse and Recycling

- Motivations for both individual and corporate participation in use of recycled and reclaimed materials are similar
- Factors influencing participation include awareness of successful businesses and projects creatively using or managing waste, green rating systems, tax incentives, access to materials and markets, and market growth

All of the interviewees were asked to provide their motivations for using or dealing with UBMs in their own projects. The main motivations listed for personal participation in personal

renovation projects were concerns about the environment and the impacts of resource use, the idea that useful materials should not go to waste, the opportunity to grow knowledge and change practices within industry, economic opportunities, and finally, the high quality of old materials.

When asked for the motivations of their company for its role in RRR of CRD materials participants indicated that the motivations also often represented benefits or opportunities to the business. The main motivations for company involvement were the potential to save or make money through salvage or reuse of materials, the economic opportunities provided by RRR of materials, concerns for the environment, opportunities to provide leadership through knowledge development and changing business practices, and finally, the intrinsic value and quality of old materials.

Interviewees discussed several factors that help to shape attitudes and behaviours. These included incentives, awareness of successful business models, recognition for efforts, and accessibility of markets. According to nine interviewees incentives are an area where government seems to have a large role to play in RRR market growth because only government has the opportunity to create a playing field that is tilted towards better waste management practices for CRD wastes. These nine interviewees also indicated that unless key factors contributing to waste flowing to landfill are addressed it is not feasible to think that reuse and recycling of materials will become commonplace in the immediate future.

Six respondents indicated that by seeing, hearing about, or reading about successful businesses across North America they were influenced to either change their own business practices or to at least consider that there were alternatives to traditional construction waste management. Several Ontario companies were referred to who made sustainable materials management a part of their business by witnessing successful companies using CRD waste as a

primary part of their businesses around the world. Four interviewees provided examples of companies that run closed loop material cycles, taking back their own materials from CRD sites and remanufacture the components into new materials, thus producing as little waste as possible. There were examples given of markets in various provinces and states across North America where the UBMs industry is thriving and people have come to expect and rely on specific locations as a consistent source of high quality materials. Examples of successful businesses demonstrate that success can happen with UBM markets and that money and cost objectives can be met or overcome if there is a willing consumer base and a welcoming business environment. A couple interviewees had used these businesses as examples or models for their own business practices or and a strong majority of interviewees wished that the Ontario business environment were friendlier to these businesses and strategies.

All but one of the interviewees agreed that green building rating systems in Canada have contributed to UBM market growth simply by making more people aware of the possibilities of what can be done and requiring improved waste management practice to achieve certain points within these systems. Of course with improved practices and recycling and reuse requirements there is also a direct impact on both supply and demand for reclaimed building materials. These interviewees indicated that it is important that green building rating systems continue to provide recognition of projects that achieve a high standard for sustainable construction practices. They agreed that this creates greater awareness of potential sustainable waste management strategies amongst professionals and regular citizens which can trickle reclamation strategies into even the smallest of renovation projects.

Three interviews indicated that the not for profit UBM retailers in Ontario benefited from the HST being implemented because it meant they no longer had to pay taxes on any of their sale

items and they can pass along tax receipts for full sale value of products to material donors. This benefits the organization that sells the materials, the donor of the materials who gets tax receipts for 'waste' materials, and the customer who does not have to pay tax on materials. Two interviewees suggested that awareness of this tax incentive might motivate consumers and contractors to donate materials to these types of UBM retailers because of the potential benefit for doing so. These interviewees indicated that they are always trying to raise awareness of this benefit to consumers, in particular contractors, within their communities. This tax incentive is not without its issues though. A major problem that surrounds tax incentives for material donation to charitable organizations that sell UBMs is that the private businesses who also deal in UBMs are forced to compete on an uneven playing field. All three interviewees pointed out that these businesses have to pay taxes and employees whereas the not for profits survive primarily with volunteer labour. This was a considered a discouraging factor for private enterprises trying to make a living selling UBMs. Entrepreneurs that do attempt to run a UBM business often end up doing more salvage and specialization as retailers focusing on older and unique materials in order to cover costs. This demonstrates some Ontario specific problems relating to awareness and incentives for running a private UBM retail business.

Access to UBMs and markets supply them is a factor that interviewees insisted affects participation. Six interviewees indicated that the markets for RRR of building materials are directly impacted by the distances between materials and the projects that need them. This is because transportation is expensive and accessing items from a great distance is often considered a hassle for both consumers and suppliers. Five interviewees indicated that UBM retailers and CRD contractors will not travel great distances to collect UBMs or deliver them to appropriate facilities because they cannot pass these costs along to consumers. These costs have to be taken

into consideration by the customer or need to be worthwhile in the sale prices of the materials being retrieved by the UBM retailers.

Access to materials and markets was also considered in terms of what is available for reuse on site or salvageable nearby. For reclamation efforts to succeed depends on multiple factors, including the relationships a company or individual has within their community, the facilities that are locally available, and the quantity of material both required and available at a given time. For these reasons a strong majority of interviewees indicated that RRR activities were more likely to succeed in urban areas due to the higher density of reuse and recycling opportunities occurring nearby in urban areas. Four interviewees who used a lot of reclaimed materials in their work emphasized that they consistently used both personal and professional connections to access a variety of waste materials for use in renovations.

4.2.4. Materials

- Demand for materials varies in terms of recycled and reclaimed materials
- Many materials such as bathroom fixtures, flooring, doors and windows are easily and commonly recycled, reclaimed and reused in Ontario
- Materials that were considered difficult to recycle, reclaim, and reuse include out of date materials, contaminated or hazardous materials, and limited quantity materials
- Materials are sourced from a variety of formal and informal markets and need to become more consistent
- Materials are reused in both common and uncommon ways in construction projects Markets for recycled and reclaimed materials are best suited for residential renovation projects

Many issues were addressed by interviewees when asked about materials suitable for reuse and recycling which can have an impact on whether consumers chooses to participate in the RRR markets in Ontario.. These issues included the demand for materials, the types of materials that are available, those that are easiest and most difficult to RRR, sources for materials, how they are typically used, and what segment of construction is best suited for UBM markets.

Demand for materials varies in terms of recycling and reclaimed materials. Two interviewees who worked in the recycling industry stated that they could never get enough materials and they would easily be able to run multiple shifts every day if they had access to more materials. They noted there are always demand for recycled wood, plastics, cardboard, aggregates and metals. In terms of salvaged materials it was noted by all of interviewees that some materials are constantly in high demand, such as doors and windows and design trends that are prevalent at any given time have a major impact on demand for specific materials. Since trends can shift quickly, something that is in high demand can suddenly be out of style. Two of the interviewed retailers noted that this constant flux in fashion means they need to move materials quickly for fear of being stuck with capital invested in undesirable materials or products.

The easiest to reclaim materials were surprisingly common across all interviewees and consisted of either raw materials or building products which consumers can easily understand how to reuse. The separation of raw materials and building products was thought to extend to differences in salvage and recycling markets. Salvage markets seek either finished products or materials that can simply and easily be reused within a renovation project. Bathroom materials and plumbing fixtures, such as sinks and bathtubs, as well as flooring were discusses as easy to

reuse since they can be replaced ‘as is’ in construction projects. It was also noted that these types of components are all relatively simple to extract from renovation or demolition projects.

Recycled materials markets on the other hand, are looking for raw materials that they can easily separate and then break down further during processing. These raw materials are then sold to manufacturers for use in new products. Raw materials like clean wood, metals, and aggregates were commonly discussed as easy to recycle and reclaim. Markets are already established for these materials because there are many uses and markets for these salvaged materials that exist in Ontario.

Eight interviewees stated that reclaiming materials is difficult based on a number of factors that are often job site specific. If the materials are fastened together in a way that makes their intact extraction or separation difficult, easily recyclable and reusable materials will wind up in the landfill. Anything that was contaminated with hazardous materials was also considered difficult to manage for obvious reasons. Limited quantity materials are often difficult to sell for UBM retailers. In particular two interviewees noted that siding and brick are available only in small batches comprising whatever materials were leftover from a job site. This meant that there may not be enough of a similar material to make it feasible to use them on a project. Finally, two interviewees suggested that plastics present an ongoing challenge to recyclers because there are many varieties which makes sorting difficult, costly and time consuming without proper equipment.

All interviewees were asked to describe the sources for UBMs they or their companies had used. They listed a variety of sources including private salvage opportunities, public auctions, yard sales, waste bins of construction sites, scrap yards, roadside wastes, product manufacturers, donations, and finally, personal connections and those made through classified ad

websites. Materials coming into the reclamation industries arrive mainly from demolitions and renovations according to those interviewed. However, some materials come direct from excess materials leftover from new construction. Other materials never even make it to a construction site as six of those interviewed indicated that a large volume of product in not for profit UBM retailers comes from traditional building materials suppliers who clear their shelves and get a tax receipt for their donations. The bulk of reclaimed materials flow from ICI demolition and renovation projects however, individual renovations account for the most frequent contributors of materials to UBM retailers and recycling facilities. This difference in bulk and frequency of materials flowing to RRR companies has to do with the frequency and scale of different types of projects within each sector.

Ten interviewees and their companies have participated in salvage or have had materials given to them through informal markets. Both casual and professional relationships provide the connections to UBMs that many of the participants discussed. Three interviewees indicated that if one is in the business of reusing building materials they always need to be on the lookout for materials they can potentially use since the informal opportunities can present themselves at times when one may not even be looking for particular materials.

4.2.5. Who Are Markets Best Suited For?

Eight interviewees believed that that the main shoppers in UBM retail locations were primarily composed of homeowners and small contractors working on behalf of residential renovation clients. There is some demand from commercial enterprises but this is on a project specific basis. Four interviewees indicated that some consumers had expectations that could not possibly be met based on pop culture experiences such as TV, magazines and the internet. Expectations for high quality finished products using UBMs from individual homeowners were

very demanding for contractors to meet and seemed to deter some contractors from participating in their use.

Although materials come to UBM suppliers from a variety of sources, four of the respondents said that homeowners and residential renovators that bring in kitchens and bathrooms are more common than large scale ICI contractors bringing in individual components. It was noted that both new and used products get brought to retailers and recyclers from renovations and new construction projects.

The majority of interviewees believed that because there are so many residential renovation projects each year and due to their small size and scope they represented an important opportunity for reuse and salvage. This was primarily because there are fewer materials involved in these projects compared to large ICI projects, and thus UBMs could more easily fill the requirements and demonstrate possibilities for greater reuse in the future. Four interviewees also noted that there could also be substantial savings if major components of a residential renovation can be purchased used.

Three interviewees implied that there was a need for a business that provides a kind of middleman service between those looking for materials and those that have materials available. This would fill the gap that many interviewees identified between sourcing materials when needed and the time and energy required to do so. Six interviewees noted that while many individual homeowners and contractors may be willing to reclaim or reuse components they may not be either willing or able to source materials nor to pay for the costs of doing so. This type of business could act as a connection and provide awareness both of what can be done with UBMs and also where these materials can be found.

Finally because of the limited quantities of UBMs that are often available seven interviewees indicated that they felt residential renovations are the best possible markets for reuse. This was because the quantity of materials needed in these projects is limited and the aesthetic that is required is also more adaptable based on personal tastes instead of corporate image or design requirements.

4.2.6. Barriers to Reclamation, Reuse and Recycling of UBM's

Interviewees were asked to name the barriers to RRR of CRD materials, and in particular for barriers to RRR of materials within residential renovations, which as discussed previously, most respondents believed was the best and most active market for the salvaged materials. There were many different barriers discussed by interviewees and the following section discusses the most common barriers cited by interviewees.

Four interviewees discussed that reclamation for reuse and recycling and other forms of waste reduction is not often a consideration for individual residential renovators or their contractors. Renovators and CRD professionals are not thinking of ways to reduce waste through recycling and reclamation, nor are they trying to incorporate used materials within a project. The interviews indicated that individual homeowners do not consider or may not be aware of the impacts of building materials and may consider their project's impact insignificant. Individual homeowners doing a renovation may not be aware of the potential for sustainable waste management strategies simply because they are not involved in the construction industry on a regular basis. Many consumers may not know that materials needed for their renovations could be available at UBM retailers because they don't know such stores exist. Interviewees concluded that greater leadership needs to be shown by CRD professionals, because they are aware of such

possibilities and are capable of contributing their own and their client's wastes to reuse and recycling facilities.

The storage of building materials was discussed by six interviewees as a barrier to greater RRR of materials in residential renovations. On individual job sites space is often limited and so many of the respondents cited concerns with the storage of materials as a common barrier to reuse and recycling of construction materials on CRD sites, and particularly residential renovation sites. Three interviewees indicated that this was a particularly large problem in urban areas where space was generally more limited than in rural areas.

For contractors the purchase or salvage and subsequent storage of used materials on speculation of a future use coming available was an issue. Four interviewed contractors stated they would love to keep, use, and buy more salvaged materials however most companies have limited storage capacity and so will not keep materials if they do not have an immediate use for them. Storage can result in additional costs due to damaged products and the transportation and labour to move product around.

For UBM suppliers, space is at a premium and they often are forced to reduce prices on items to clear space in their limited retail environments. For example, one respondent who managed a UBM retail store described cleaning the warehouse space as "...dumpster therapy that happens every so often" in order to clear out slow moving items to make space saleable items. These retailers need to have access to space for new material to come and go from there stores. The store managers and owners that were interviewed understand the value of the materials but simply cannot hold onto things forever with the hope of eventually making a small amount of profit. Thus, the storage of materials is a logistical problem that can limit what is available at reuse stores and what is immediately available to a renovator.

Seven interviewees said that the use of RRR materials must be client driven in order to affect change in waste management. They suggested that companies will not make changes without the insistence of their clients as a difficult and common barrier. This is because project owners may not know about possibilities for reuse, salvage, and recycling and so may not insist on these practices. Without the demand from the client most contractors will not use alternative waste management solutions on their own because of their perceptions about time, costs, and waste resulting in valuable materials simply being disposed of or never considered for use. It is a double edged sword because if clients do not demand these products and services then contractors will not increase their level of participation. The barrier then is not purely that the change needs to be client driven but that contractors are not viewing this as an opportunity to grow and advance their businesses. A few of the interviewees stated that clients also source materials themselves, however upon seeing the prices to have materials or products refurbished or repurposed into their project they may choose instead to go with new materials. This is because labor costs are high to refinish a material relative to material costs. One UBM retailer, who specializes in architectural salvage and in refurbishing old materials, noted that when people bring materials to them for refinishing his company end up working for wages instead of profit. This limits the amount of this work that they do because it is not good for business and customers often do not understand why it costs so much for the refurbishment of a single component.

Two interviewees noted that although recycling is commonly practiced and understood in Ontario households, at least in terms of common household materials, the salvage and reuse of CRD materials is not. Recycled materials are more common than people realize and there are many recycling processes that are already developed but may not be available in all locations.

One respondent discussed how recycling is already happening and that individual homeowners do not necessarily need to be aware of what is happening regarding the recycling of materials so long as recycled content products of equal quality and are competitively priced with new materials. On the other hand, the majority of respondents noted that reuse in general is not as common and reusing building materials is something that requires specific projects, consumer characteristics, and aesthetic appreciation. Reuse of salvaged materials however, requires a renovator deliberately seek out specific materials and be willing to make them work within a renovation project.

Three interrelated ideas were commonly mentioned by interviewees surrounding the supply of UBMs, first the availability of materials when needed; second, the bulk or volume of the supply available; and third, the reliability of the supply. If any of these three are lacking then the likelihood of materials being reused on CRD job sites are greatly diminished because materials are required to be available when needed and in sufficient quantities. Materials also need to meet at least a basic level of quality for contractors or homeowners to consider using them within their renovations.

Seven interviewees noted one major problem with supply of UBMs was that there are not UBM retailers and recyclers in every community. Certain communities, such as Toronto or Ottawa, are well served by a variety of both traditional and alternative waste management facilities however there are many areas within the province that have major difficulties dealing with wastes. Northern and rural communities were discussed as lacking local recycling facilities and reuse stores. Lack of access to materials extends also to the internet which is where a lot of modern day shopping and material awareness takes place. Given that traditional retailers have

every item categorized online the lack of online availability of most UBM retailers is a distinct disadvantage.

Lack of high quality materials also was discussed by five individuals in terms of the potential building performance being affected by using inferior reclaimed materials. These interviewees discussed that many contractors, including themselves in some cases, were not willing to reuse certain building components because they would negatively affect the building performance in terms of energy efficiency and building performance. In one particular example the contractors were often asked to reuse old windows within projects however the low quality and performance of these relative to the costs to fix and/or upgrade to a high level of performance made this undesirable.

The attitudes regarding waste of those within the CRD industry were considered major barriers to RRR of CRD materials. The main themes that emerged regarding attitudes included lack of concern for the environment, the willingness to put forth the extra effort required to responsibly manage materials, the idea that waste is an unavoidable consequence of construction projects, and the idea that corporate competition and the desire to make profits makes responsibly managing waste and incorporating reclaimed materials unfeasible.

Concerns over the environment do not factor in for all those doing CRD activities. Three interviewees stated that in response to environmental efforts made on their job sites they occasionally witnessed attempts to sabotage waste management plans out of either ignorance or maliciousness by either or both their own employees and subcontractors. Many project owners are only interested in the outcomes of their own projects and a few of the interviewees noted that like many industries, the CRD industry does not factor in externalized costs into a project's

material costs. Contractors and individual homeowners do not see their own waste pile as a problem in the grand scheme of things.

Four interviewees discussed that making a profit drives business and in construction it is an easy excuse for continuing with business as usual practices and not changing to a sustainable business model. It was noted by a couple of respondents that some traditional building supply retail chains have realized they can make a positive difference within their communities through the donation of materials to UBMs retailers and also get a financial benefit through tax breaks. However, three interviews also indicate that there are still many companies that see UBMs suppliers as direct competition and so would rather see materials head to landfill than make a donation of valuable materials.

Knowledge and awareness of RRR opportunities was a very commonly cited barrier amongst interviewees. In particular, knowledge and awareness is lacking in terms of what happens to materials once they leave a construction site, knowledge and awareness about already existing markets and what is possible with RRR materials.

Lack of knowledge about the problems of waste means that individual homeowners, contractors, and large companies may not realize the impacts they are having on the world at large. Five interviewees stated that companies often try to do the right thing and even claim they have incredibly high diversion rates however, these same companies may not know what happens to their waste materials once they leave the job site. For example, one interviewee representing a large commercial contractor stated they had a “90% diversion rate.” He followed this up later in the interview by stating that he had no idea what waste haulers did with the waste once it left the construction sites. For his company, claiming a high diversion rate was a sales

tool and the actual outcome of what happened to the materials did not matter. They preferred to stay unaware and trust blindly that things were done properly elsewhere.

Three interviewees noted that there is a general lack of knowledge about where private waste flows to in Ontario. For example one interviewee who represented the interests of companies who deal with 85% of waste hauled in the province, stated that “we do not have a good sense of what is happening in terms of the flow of materials.”

The problem with a lack of knowledge about existing markets affects both the supply and demand of UBMs. First, people do not know that they can purchase any materials used and that many products and materials are available at all. Second, this same lack of knowledge of markets means that companies and individuals do not contribute their own materials to a UBM retailer.

Interviews with six individuals showed that a lack of controls over waste on private sites, a lack of proper enforcement of regulations, and few incentives to reduce waste on construction sites is a major barrier. Many of these participants noted there are basically no controls on an individual low-rise residential property owner as to how they should manage CRD wastes. The existing regulations within the province pertain to buildings over 2000 square meters however interviewees stated that they are not enforced with any regularity and they obviously do not apply to low-rise residential buildings. This demonstrates a lack of incentive to reduce the amount of waste generated in general and discourages reuse and recycling of materials within small scale renovation projects. If there is no penalty the majority of consumers and contractors will take the path of least resistance which in the case of CRD waste is landfilling. Landfilling also remains relatively inexpensive due to a lack of landfill bans, and no penalties for disposing of CRD wastes and so the majority of materials end up unsorted in landfills.

Economic factors in at least some capacity, was cited as a barrier to RRR by all interviewees. Three main ideas relating to cost were discussed by interviewees, first the idea that it is not cost effective to RRR; second, the formal markets suffer because of the informal economy where people are selling materials themselves before they donate or give them to a UBM retailer; and third, labour costs are expensive relative to material costs in Ontario. These costs can be seen as a major deterrent to the RRR of materials for residential projects where costs are an important factor in getting a job done may be the deciding factor in whether to use new or used components. This is especially true when a customer knows what they want in terms of a finished product and both new and used components are similar in costs. Unless significant savings can be achieved most often individuals will choose the new materials.

Four interviewees pointed to the proximity to the USA and their massive landfills as a major barrier to growth of existing markets and increased RRR in Ontario. These interviews indicate that this geographic proximity and the low costs of disposal in these ample landfills directly affect costs of landfilling in Ontario and make the costs associated with deconstruction, resale or repurposing of materials if not higher, then certainly more difficult than disposal. Two interviewees discussed how a major part of the problem is that not a lot is known about how much CRD waste material is currently crossing the border into the USA.

The transportation of materials from job sites to waste, reuse or recycling facilities was discussed as a barrier by five respondents. Because transportation costs are high, materials are generally sent to nearby facilities. Contractors do not want to pay exorbitant fees to transport waste to facilities that are few and far between that properly manage wastes. UBM retailers need to make money on items so they require that transport costs stay in line with what they can ultimately charge for a product. Finally, consumers want to be able to use and recycle materials

however this is not at unlimited expense. Sometimes for individual consumers it is also an issue of not having the proper equipment or vehicles to transport materials.

Time is always a major consideration for any CRD project. The majority of interviewees consistently said that RRR of materials takes too long relative to simply throwing everything in one bin or buying all new materials. Time is therefore considered a logistical barrier in that it takes longer to conduct the work of reuse or repurposing, and to deconstruct, and sort materials. Time was also considered an issue in the procurement of materials as most renovation projects are on tight timelines and as such require materials to be on hand when needed without delay. Searching for specific materials can be time consuming which is something many clients may not be willing to pay for.

Five interviewees discussed that renovation contractors could be leading the way with the RRR of material choose not to participate in the use of these materials. When contractors do not participate in these markets it creates problems in both supply and demand. Two interviewees indicated that many contractors choose not to work with these materials even if requested by a client. This was because of the time and effort required to source specific materials and a perceived lack of willingness by clients to pay for this sourcing service. Changing waste management strategy from one job to the next was said to be extremely costly and inefficient according to interviewees.

Finally, three interviewees discussed the aesthetics of reclaimed materials, how some people simply do not want old materials because they prefer the look and the perception of cleanliness that new materials provide. One interviewee described it as “a matter of taste” as a reason why some people did not shop in UBM stores. The aesthetics of waste management while work is under way can be an issue. One of these interviewees mentioned sanitary issues

regarding where UBMs had come from as an obstacle to wanting to personally use them or selling them to clients.

5. Discussion and Conclusions

The purpose of this research was to analyse CRD waste management and reduction strategies in Ontario and to test whether residential renovations provide a viable option for the reuse of salvaged building materials in order to reduce the overall amount of CRD materials sent to landfill each year. In order to do this four main objectives were set, first, to identify the markets for recycled, reclaimed, and reused CRD materials in Ontario; second, to identify materials commonly recycled, reclaimed, and reused within residential renovations; third, to identify attitudes, awareness, and levels of participation of leading green building professionals regarding the use of UBM markets; and fourth, based on the first three objectives, identify common barriers to the use of recycled, and reclaimed CRD materials in residential renovation projects. The following section discusses the results from the mixed methods surveys as they pertain to each of the four research objectives.

5.1. Objective #1: Identify Existing Markets for UBMs in Ontario

The research showed that there are markets available for both reuse and recycling of CRD materials at this time and that the markets for reuse and recycling of materials are significantly different. There were several key outcomes that affect the existing markets for materials in Ontario that are similar to findings in research and practice in other parts of the world. First, the availability of markets with consistent and quality materials is required. Second, the lack of regulations, enforcement, and incentives to recycle and salvage CRD materials in Ontario contributes to a lack of participation in markets for UBMs. Third, the logistics of handling CRD wastes limit potential market growth. Fourth, the change to more use of UBMs needs to be client driven if it is going to happen in residential renovation sector.

There are markets that exist in Ontario for reuse, repurposing and recycling of CRD waste materials. The research showed that there are both formal and informal markets that exist within the province. The formal markets consist of both private and not-for-profit organizations that run retail stores focusing on a wide variety of CRD materials for resale. Habitat for Humanity lists 49 ReStore retail locations within Ontario. 35 of these serve southwestern and central Ontario (west from Windsor to Oshawa and north to Huntsville); 8 are in eastern Ontario (Peterborough/Belleville area to Ottawa/Cornwall), and 3 serve northern Ontario (Sault Ste. Marie, Sudbury, Thunder Bay) (Habitat for Humanity, 2013). The research also indicated that there are several small for-profit retailers across the province who sell mainly high end architectural salvage components. Private retailers are generally located in the same communities as the HFH locations with very little service of rural and northern communities. These retailers find it difficult to compete with the not-for-profits in terms of more common UBM's because they do not get the same tax benefits and volunteer labour force as not-for-profit organizations. This uneven playing field severely limits the private enterprises that participate in salvage and sales of UBMs. This particular situation seems unique to Ontario because of the Harmonized Sales Tax introduced in June 2010 and the exemptions that exist because of it. This represents an area where improvements could be made to policy, for example providing rebates for reuse of materials from private retailers could encourage these private businesses to grow into selling and salvaging more commonly used materials.

Informal markets that exist include the internet, private salvage opportunities from friends, family and neighbours, and scavenging of materials from construction sites. These strategies worked effectively for many interviewees in providing valuable materials they used in their renovations. Tools such as the proposed *Harvestmap* soon to be launched by Superuse

Studios in the Netherlands could help to expand these markets (Superuse Studios, 2013). The tool allows those with materials available for salvage and reuse to post online and show the location of material so that designers, contractors and other reusers can more easily connect to available materials (Superuse Studios). In 2013 Construction Resource Initiatives Council began preliminary development of an application for cell phones that would connect Ontario consumers and suppliers of used building materials. If this tool, or one such as the *Harvestmap* could be successfully created and adopted on a broad scale in Ontario it could make a significant impact on the problem of connecting individuals to the material that they need for individual projects or on an ongoing basis.

The research showed that one dedicated CRD waste recycling facility in Ontario at this time currently handles and recycles roughly 400 tonnes of CRD waste per day. It is currently the only CRD waste recycling facility of its kind in Ontario although Waste Management, a large publically traded company, was reportedly developing a facility in Toronto scheduled to open in late 2012 (Waste Management, 2012). These appear to be much less common in Ontario than reuse stores, however they can process massive amounts of material every day. The Ontario facilities are modeled on successful companies that they visited in the USA and around the world. They had seen these businesses and recognized a major opportunity that existed within the province of Ontario to fill the gap of recycling facilities specific to CRD materials. There is clearly a need for more recycling facilities that focus on quickly and efficiently sorting CRD wastes. The result showed that there is great potential for recycling of CRD materials in the province and that markets already exist for many of the main materials that flow from CRD job sites. If more of these facilities existed then more CRD recycling would happen because it

essentially costs the same to dispose of wastes at these facilities as at a regular waste transfer station.

The research found that the consistency, quality and quantity of available materials within the reclaimed materials markets need to be improved. This is because without guarantees that materials will be available when needed contractors and homeowners conducting construction activities and residential renovations cannot rely on these markets when planning or undertaking a project. This finding agrees with previous findings from Winkler (2010) and Green Leigh & Patterson (2006) who agree that consistency and quality of materials and markets is essential to markets developing. Without consistency CRD professionals and residential renovators will choose the easier option of traditional building suppliers for their renovation projects.

Due to a lack of enforcement of existing regulations there is not as much diversion that takes place on CRD sites as should be happening in Ontario. The research indicates that CRD and waste management professionals believe that without more incentives introduced within the province there are not likely to be any changes in the amounts of materials that are recycled or reclaimed with the intention of reuse. This is reiterated by the recently proposed Ontario Waste Reduction Strategy which states that “Ontario has lagged behind other jurisdictions in Canada and around the world” in terms of overall waste reduction (the Government of Ontario, 2013). The strategy goes on to say that this is in part attributed to the lack of 3Rs participation by the ICI sector, which coincides with the findings of this research. The residential market is already a leader in terms of recycling and diversion of regular wastes so they can also lead the way in terms of materials reused in renovations. The proposed Waste Reduction Strategy is in its infancy, undergoing public consultations at the time this thesis was being completed. The

recommendations of this research shall be shared during the public consultation process by the researcher.

The solutions recommended by those participating in the research included landfill bans for recyclable materials, tax incentives, rebate programs to business and individuals for alternative waste management practices, and increasing awareness through public awareness of projects successfully and creatively using salvaged building materials. Better incentives could potentially increase the amount of materials that would be available for reuse within residential renovations, and could help to expand the markets for salvaged materials. Increased volumes of materials available for reuse and recycling would present an opportunity for residential renovations to act as a driver for change because if they increase their demand for UBMs then the markets themselves will begin to grow.

The research indicates that the costs and logistics of managing CRD wastes are prohibitive if there is no end market for these materials. This is because the costs of landfilling of all waste remain low in Ontario relative to costs of transport, storage, sorting, and handling of materials. This coincides with previous publications that discuss how logistical issues can prevent reuse if not considered before a project begins (Calkins, 2009).

The change needs to be client driven in order to get contractors to buy in to the reuse model of renovating. These findings agree with Kibert (2008) and Crawford, (2011) who stated that the owner must decide on the priorities of a green CRD project from the very start. Only through increased awareness of the problems created by construction waste and issues of resource efficiency will increased client demand for reused and recycled content become the norm. The research indicates that individuals and renovation contractors representing them are already the primary participants in the purchase of UBM's in Ontario. Without greater demand

from individual homeowners for salvaged materials and more recycled content in new materials then changes will not occur organically within the industry itself. Contractors generally refused to participate because of perceived increased costs that consumers are not willing to bear. Addis (2007) notes that some potential increased costs can be overcome if developers and clients are willing and tolerant partners in making reuse and recycling happen. It is important to note that some interviewees in this research and an Australian study showed that substantial savings were possible with the use of salvaged building materials (Treloar, Gupta, Love, & Nguyen, 2003).

5.2. Objective #2: Identify Materials That Are Commonly Recycled and Salvaged for Reuse

An understanding of materials that are commonly recycled and salvaged for reuse was required to understand what is available and viable for reuse and recycled than others in Ontario. The key outcomes from the research regarding materials are that there are some existing closed loop systems in Ontario, and some materials are easily and commonly reclaimed or reuse and recycling in Ontario however there are significant difficulties in the use of certain materials and under certain job site conditions.

Kibert (2008) notes that closed loop systems involve keeping materials in productive use by reuse and recycling and materials such as drywall, carpet, wood, aggregates, and metals are already a part of these systems to varying degrees in Ontario and were noted to be commonly and easily recycled. Reuse, it seems, is not as well understood and practiced less often. Sourcing of materials is an issue that emerged and this comes down to some awareness issues and willingness on the part of all involved parties to put in the required effort to seek, find and reuse components. There are some materials that were noted to be extremely difficult to deal with during demolition or deconstruction of a renovation project or else difficult to work with in the

construction portion of a project. These materials included out of date materials such as single pane windows, and plumbing components and products with potentially hazardous contaminants, like lead based paints. Difficult to separate and sort materials are always a problem and this coincides with previous research such as Kibert (2008) who notes that “products in closed loops are easily disassembled and capable and worthy of recycling.” The research also indicated that working with certain salvaged materials is also difficult. However, the results can be high quality and all that is required is extra time and a bit more care in the demolition stage of the renovation project in order to prevent wastes.

Research indicated that there is a lack of consistent supply of both recyclable and reusable materials. Recyclers participating in this research noted that if they could access more materials they could operate their facilities around the clock. This is because the markets for all of the easily recycled products like wood, plastics, aggregates, metals, non-ferrous metals, and cardboard are already well established. These materials make up the majority of CRD wastes that are commonly disposed of (Calkins, 2009; Roper, 2006; US EPA, 2003; CH2M, 2000; Sandler, 2003). If markets exist and recyclers want more then there is somehow a problem with getting awareness of the value of these materials to CRD professionals who are disposing of materials on regular basis. Reusable materials require greater efforts to salvage materials and find locations at which to donate or sell them. With the Canadian Standards Association publications *Deconstruction of Buildings and their Related Parts* (2012) and *Guideline for Design for Disassembly and Adaptability of Buildings* (2006) recently established, hopefully more will be accomplished regarding better waste management within the Ontario CRD industry and the materials available for reuse and recycling will improve in consistency and quality over time.

5.3. Objective # 3: Identify Attitudes, Awareness, and Participation

The third objective of the research was to identify the attitudes and awareness about UBMs and the levels of participation of green building professionals in their use. There were four key outcomes of the research regarding attitudes, awareness and participation. First, there is minimal concern and knowledge for the impacts of CRD waste materials generated in Ontario on the greater environment. Second, there are strongly held opinions and attitudes about waste, costs, and reuse of materials that hinder progress in alternative waste management systems becoming more commonplace. Third, awareness of markets for materials and of alternative waste management practices within the CRD industry is low. Fourth and finally, despite all of these negative attitudes and issues around awareness there is an understanding of the value of the building materials that are being disposed of on a regular basis and a desire for expanded markets for reuse and recycling in Ontario

It became apparent from the research that knowledge is lacking within the industry of the problems and context of CRD waste. People who are unaware that CRD is a substantial part of the overall waste generated within the province will not seek alternatives to traditional disposal. This coincides with previous research that indicates market prices do not reflect the true costs that they inflict upon the environment (Roper, 2006). It is therefore not unique to Ontario that individuals, both private citizens and CRD professionals do not understand that alternatives exist which can be pursued. If awareness does not improve of the impacts of construction activities in the province of Ontario on greater environmental issues that affect us then massive amounts of waste will continue from the CRD industry. Addis (2007) suggested that inertia was a great barrier to greater reuse and recycling because in the CRD industry the business as usual approach is so readily adopted. There are some organizations within Ontario that are attempting to change

this. For example, the Construction Resource Initiatives Council launched Mission 2030, a zero waste challenge for the construction industry, in hopes of getting construction projects to have zero waste originating from construction sites by the year 2030 (Construction Resource Initiatives Council, 2013). This research indicates that there are many strongly held opinions that cost of recycling, reuse, and reclamation of CRD materials from construction sites is too costly, too difficult and simply not possible. The Old to New Design Guide (2001) published as a guiding document for construction companies in the greater Vancouver region provides comprehensive lists of costs of reclaimed materials versus new. They very clearly state that the savings found in used materials can be substantial. This lack of willingness to participate seems to stem from the simple lack of desire on behalf of many of the construction professionals to conduct their businesses differently. Cost was noted by some interviewees as the easiest excuse for not adopting alternative waste management practices. At the same time the Likert survey indicated that many felt costs could be saved through reclamation and reuse of building materials. Because there is little research regarding actual costs and cost savings in recycling and reuse of materials the argument of costs being prohibitive continues to hold sway in Ontario.

There is a low level of awareness within CRD professionals and waste management professionals about markets for UBMs. This could be because retailers of these materials do not exist or are poorly advertised within all Ontario communities. Another possibility is that people are not looking for them in the first place. In order to address the awareness of reuse and recycling facilities in Ontario there needs to be greater emphasis place on the education of tradespeople and CRD professionals about what is possible with waste materials from the earliest stages of their training. Green Leigh and Patterson (2006) noted that education and awareness campaigns about deconstruction, markets, and materials are needed to improve waste

management practices. Nothing will change in the upcoming generation of CRD professionals if this is the case. The University of Georgia in Athens, Georgia runs a program that focuses on reuse of construction materials removed from the campus and local area as a part of its College of Environment and Design. They salvage materials and reuse them in “community based and student design projects” (The Material Reuse Program, 2013). They do this to demonstrate the value of “waste” materials and to train designers of the built environment to “turn the dilemma of waste into an asset for the community” (The Material Reuse Program, 2013). This type of training needs to be brought to Ontario as there is no such program focusing specifically on CRD materials reuse in any Ontario college or university, nor is there any emphasis placed on educating trades on responsible waste management practices in Ontario at this time.

It has been recommended within previous literature that the best way to improve awareness of what is possible with reuse of materials is through concrete examples (Addis, 2007). This was reiterated within this research by the interviewees who thought of every reuse project as a method of education for themselves, their clients and the greater community. The research indicated that those conducting CRD projects with UBMs often considered it an educational opportunity for all involved. This coincides with many organizations across the United States that use reuse and salvage programs as skills development and education opportunities for people in need of job skills. For example, Finger Lakes ReUse in Ithica, New York has a program called ReSET that focuses on teaching deconstruction techniques which provides skills and valuable materials that can be reused (Finger Lakes ReUse, 2013). These programs educate the workers and also the community about what can be done with materials. Greater emphasis on skills development of this sort could lead to the development of more companies that focus on this type of work and increase the amount of materials that are available

for reuse as well as increasing the awareness of reuse projects within various communities. These are small programs that lead to better practice and education of worker that if adopted in Ontario could lead to the expansion of the markets for reclaimed building materials that is wanted by such a strong majority of participants in this research.

There is an issue of awareness of initiatives within the industry regarding alternative waste management. This may be because in Ontario, as in other regions of North America, they are not happening, but also because companies that are doing things differently do not want to share information that differentiates them in the competitive construction marketplace. This ultra-competitive environment could contribute to the lack of awareness of initiatives within CRD industry. The interviews did indicate that awareness of initiatives can also cause competitors to change their businesses to emulate successful companies.

The research indicated that residential renovators are already the most frequent users of UBM markets. This was partly because of the small volume of materials they are seeking relative to other types of construction, the possibilities of realizing noticeable savings on individual building components and a willingness of individuals to undertake a project with alternative building materials. As noted in previous research the residential renovation market seems particularly well suited to reuse because of the small scale of projects (Kernan, Kadluski, & Labrie, 2001). If more willingness can be enshrined in this market then there is major potential for decreasing the amount of waste from CRD sites through reuse within residential renovations.

Finally, there appears to be an understanding within green building professionals of the benefits of UBMs and a desire by professionals to expand the markets for reuse and recycling. Individuals participating in this research indicated that they know used materials are a valuable resource and yet strangely they still do nothing about it either personally or professionally. This

indicates a problem with the leadership qualities within the Ontario green building industry. It is almost as though these CRD professionals are waiting for some major changes to occur before they will choose the path of RRR. A few were taking the bull by the horns and leading by example but this was the exception and not the norm. The ultimate incentive in the construction industry is money and if a large number of residential projects suddenly were demanding used materials, the cost benefit of recycling and reclamation would improve versus straight disposal. This shows that there may need to be an artificial stimulus of the markets in terms of incentives or rebate programs, such as the Ontario Home Energy Savings Program, that have worked successfully in Ontario in the past (Environment Canada, 2012). One such program exists in the County of Los Angeles, in California, USA. They implemented the Construction and Demolition Debris Recycling and Reuse Program in 2011 (County of Los Angeles Department of Public Works, 2013). This program places the burden of responsibility on the owner of a property and requires a minimum of 50% up to 65% recycling rate by weight for all construction and demolition projects (County of Los Angeles Department of Public Works). The program works by providing lists of acceptable facilities to deliver materials to and having owners obtain and keep all weight tickets from waste facilities they have materials delivered to. Any material disposed of beyond the applicable rate results in a monetary penalty starting at \$100 per ton. A program like this could be implemented for Ontario construction projects and could greatly enhance the amount of material that is diverted from landfill.

5.4. Objective # 4: Identify Common Barriers to the Use Of Recycled and Reclaimed CRD Materials in Residential Renovation Projects.

Having identified the existing markets, issues surrounding materials, and the attitudes, awareness, and participation of CRD professionals in the markets for UBM's the research

intended to identify barriers to CRD waste reduction and residential renovations using more reclaimed materials and becoming a means of reducing overall CRD waste emerged. Several key themes emerged from the mixed methods surveys and these have been identified hereafter as primary barriers to waste reduction because they incorporate many of the smaller issues that were identified in the research.

The first of the primary barriers that emerged from analysis of the research was that there are low levels of awareness of markets for UBMs and there is also a knowledge gap for how to reuse these types of materials if they have been salvaged. Although survey respondents were generally aware of both initiatives within the industry as well as organizations that collected and sold UBMs, participation was not high. Although survey respondents were aware of organizations that handled UBMs they still had disposed of materials claiming they do not know what to do with them. If this is how the leaders of green building in the province act with waste materials then there is little hope that an uneducated homeowner conducting a single renovation project is going to do any better. There are also few companies that are primarily operating as deconstruction and salvage with reuse in mind which shows a niche that needs to be filled in the province.

A large number of regions across North America and around the world have adopted or drafted construction and demolition waste management toolkits. Ontario published one small document in 2009 however, it is severely lacking in content relative to other regions toolkits (Environment Ontario, 2009). The City of Vancouver, for example, has an excellent document on how to handle demolition and land clearing debris that could be used as a model for a more in depth Ontario toolkit. It provides much more in depth information about where to find UBMs,

where to take materials for recycling and reuse, and provides multiple case studies of how materials have been successfully reused (Greater Vancouver Regional District, 2008).

The second primary barrier is the logistics of managing CRD wastes. On all sizes of CRD projects logistical problems and the associated costs limit the amount of waste that is redirected to alternative uses in residential renovations. Transporting of waste to reuse or recycling facilities may involve higher costs than disposing of them in local landfills. This is due to a limited number of facilities that are doing these activities across the province. A potential solution to this problem would be to create space at local transfer stations for better sorting of wastes and allowing companies to source materials from these locations. There is one carpet recycling company that has convinced a major municipality to provide a bin for waste carpet which he then is paid to take and has markets for once broken down into the component parts (K. McCaig, Personal communication, July 2012). Sorting, transporting and handling materials can lead to damage and increased costs versus simply landfilling them. CRD companies are not willing to absorb these costs as they are in the business of making money. Providing examples of making money off of used materials and opportunities for greater reuse and recycling could greatly improve this situation.

One of the conclusions of this research is that there is a lack of strong leadership towards improving the handling of wastes and greater reclamation, reuse, and recycling within the CRD industry that acts as a primary barrier. In *Leadership Gold* (2008) Maxwell notes that the first responsibility of a leader is to define reality. Simply in participating in research of this kind and defining some of the problems that face industry in addressing the problems of waste, members of the industry demonstrated examples of the leadership that is desperately needed. However, even amongst those responding it was not overwhelming that all of them were active participants

in their own lives and careers in making less waste in construction. Maxwell (2008) states that “leading yourself well means that you hold yourself to a higher standard of accountability than others do.” Although this is demonstrated by many of those participating in the interviews those participating in the completely anonymous Likert surveys portrayed a slightly different picture of themselves as they had poor levels of participation and did not generally encourage clients to better manage waste materials. As these were the people who are most likely to be doing advanced sustainable construction practices and waste management these individuals need to show more personal accountability in addressing waste issues. If this can be done and shown to be successful in generating business, managing wastes, and making money then more of the industry will copy-cat behind those who lead the way.

A leadership gap is a barrier to reuse within residential renovations because without the industry contributing materials to reuse organizations and recycling operations there will not be any materials available for reuse within renovation projects. Also if industry is not consuming these products and materials on a regular basis then markets need to rely on intermittent renovations of individual homeowners. It was noted by several of those participating in this research that contractors that do purchase regularly in these markets can often charge full material costs to their customers, thus making a small profit off of materials they commonly use and can find salvaged at reuse stores. This is a form of leadership because they are turning used materials into an opportunity for themselves and in doing so introducing new sustainable possibilities to the customer. This is also an example that the customer does not necessarily need to be aware that individual components are being recycled, reused, or salvaged if they are in the hidden skeleton of a renovation project or if they are in a nearly new condition that meets all expectations of quality and durability.

There appears to be a lot interest in better managing of waste materials on all type of job sites yet when it comes to personal actions there seems to be a much slower uptake. Without the leadership of those who deal with these materials on an everyday basis there is very little hope of residential renovators coming to the realization that reuse is a viable alternative to all new materials within their renovations. Contractors and CRD professionals want demand from individual homeowners before buying into these markets however and individual homeowner may have no idea that such possibilities even exist. The use of these materials and of sustainable construction practices involving materials can differentiate a business in the marketplace as indicated by this research.

The next barrier within Ontario's CRD industry is that there is currently no regulation governing the management of wastes on residential renovation sites and other small projects. In fact buildings under 2000 square metres do not need to have any sort of waste management action plan (WMAP) and even those that are required to have a WMAP are not monitored with any regularity. This leads little incentive for CRD sites to practice waste reduction strategies and to small amounts of recycling, reuse and reclamation being done. Research indicates that more companies wind up paying lip service to waste reduction strategies than actually practicing progressive waste management on job sites. Interviews indicate that even \$1 of incentive towards directing wastes to recycling facilities could turn the tables towards more sustainable management of wastes since the limited number of a facilities that do exist in the province that are conducting these activities compete directly with landfills for CRD materials. As for incentives, interviewees mentioned that even one dollar in subsidy in favour of recycling of materials instead of disposing in landfill could turn the tables. This is because they have to compete directly with landfills and a company is willing to change waste handlers for small

amounts of money per tonne. Incentives can also come in the form of increased fees or penalties for generating greater waste, i.e. disincentives. Discussion of regulations, certifications and meeting the requirements of all interested parties to ensure the quality of salvaged CRD materials is mentioned in previous research (Munroe, Hatamiya, & Westwind, 2006; van Eijk & Brouwers, 2009).

The final barrier preventing greater waste reduction and residential renovations from reclaiming and reusing more materials and thus reducing overall CRD waste is the lack of availability of materials and markets. Interviewees in this research indicated that a one-stop shop type of business that deconstructed and sold materials at a reasonable price directly to contractors and renovators would be a viable solution. This coincides with what Winkler (2010) and Green Leigh and Patterson (2006) describe as a need in the markets to achieve greater reuse and recycling. Because materials are not available consumers and contractors will go to alternative sources to find what they do need, which in this case means traditional building supply stores. Not having reuse and recycling markets locally available means that renovators will dispose of materials rather than transport them large distances to deliver them to appropriate recycling or reuse locations. This, of course is not a problem of purely the CRD industry. This is an access issue and involves the fact that Ontario is an incredibly large province. If however, the southern border with the USA could become better serviced with recycling and reuse facilities then there would be more opportunities for reuse of building material for the majority of the Ontario population and in the regions where the most amount of CRD activity takes place. Access to materials can also take place in the virtual world of the internet. If there were greater accessibility to materials online through some sort of database then greater reuse and salvage of

materials would take place. This would save in disposal costs and allow individuals to choose whether they were willing to pursue materials they may need for a renovation project.

5.5. Concluding Remarks

The conclusion of this research is that there are several barriers that exist to the reduction of CRD waste through reclamation, reuse, and recycling of building materials. However, Ontario's green building and waste management professionals believe that residential renovations could be a viable option to increase the demand for UBM's if certain changes are made within the markets for these materials. If more materials can be readily accessed and successfully used in renovation projects then the demand for more UBM's will become self-fulfilling. More education of both the public and CRD professionals can and should begin in private renovation projects through incentive programs modelled on successful programs from around the world. With success at home will come even more improvements in attitudes of all potentially involved in the use of these materials. Private practice can and will affect professional practice.

This research contributed important qualitative and quantitative survey data from leading professionals in the CRD industry in Ontario. Through analysing the opinions of those who work with CRD materials on projects year round the research demonstrated the significance of the human impacts on waste creation within the industry. It is important to note that even amongst those who identify themselves as green building professionals there are significant challenges that face industry regarding waste reduction. If these challenges exist amongst those with a significant interest in improving practice then the rest of the CRD industry poses an even greater challenge. The key contributions of this research are showing that while there are significant steps being made by industry leaders there is still much that needs to be done. There needs to be

greater participation in all types of CRD projects and those who are considered key informants on green building practices in Ontario believe that this change can best begin to happen at a residential level.

6. Limitations of the Research

The research presented in this thesis is has several limitations that are acknowledged below

- This research involved assessing only the opinions of individuals who have a vested interest in sustainable construction and waste management in Ontario.
- Surveys were conducted during a brief time period and involved only people who were willing to discuss the topic of construction, renovation, and demolition waste.
- The nature of the Likert scaled questions limits the type and depth of response provided by respondents

7. Recommendations

7.1. How to Affect Real World Change.

- Participate in public consultation process for the Ontario Liberal government's new waste strategy by recommending incentives for salvaging construction, renovation, and demolition materials, evening playing field between not-for profit organizations and private UBM retailers and encourage programs for reuse and recycling as a means of reducing CRD waste
- Creation of an Ontario focused "Old to New Design Guide" listing companies that salvage and construct with UBM's, materials that are readily and commonly reused, and with case studies demonstrating success stories of reuse, recycling, and salvage
- Development of a materials harvest map modelled on the Superuse studios for Ontario could improve willingness of individuals and contractors to use UBM's because it would decrease time required to find materials
- Provide monetary incentives for delivering materials to recycling facilities rather than waste transfer stations.
- Provide monetary incentives in terms of rebate programs for, or penalties for not meeting demonstrated levels of reuse and recycling within small projects

7.2. Future Research.

Several ideas for future research have emerged from this project which are outlined below in the form of research questions

- What are the best incentives for increasing RRR of waste materials from CRD projects in Ontario?

- How can information about reuse and recycling facilities and potential be best shared with CRD professionals and individual renovators?
- Research into what are the actual costs of salvage and reuse of materials versus all new materials in construction and renovation projects in Ontario.
- Conduct interviews and Likert scale surveys with regular construction, renovation and demolition populations and not those with an interest in green building and waste issues

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Appendix A: Construction, Renovation, and Demolition Waste Markets Survey

Construction, Renovation, and Demolition Waste Markets Survey

This questionnaire seeks your opinion on the markets for reuse, recycling and reclamation of residential construction, renovation, and demolition materials. Your answer will provide useful inputs to understand the nature of the markets for these materials. Your participation is **completely voluntary**. Your answers will be kept in **strict confidence** for research purposes only. Your time and answers are much appreciated.

The information collected will be used for a Masters of Building Science thesis on the markets for residential construction, renovation, and demolition materials; recycling, reuse, and salvage markets and waste materials flows processes. The results may also be used for publication of papers in academic journals or as part of conference presentations.

The following is a list of statements regard construction, renovation and demolition waste. Please circle or place an X indicating **the extent of your agreement** on each statement using a scale from 1 to 5 where 1 indicates ‘strongly disagree’; 2 ‘disagree’; 3 neutral; 4 ‘agree’; and 5 ‘strongly agree’. Please answer based on your personal opinions and experience.

Statements	Level of Agreement					
	<i>Strongly disagree</i>	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>	<i>Strongly Agree</i>	<i>Not Applicable</i>
1. Residential renovation and demolition waste management is an important issue	1	2	3	4	5	6
2. Zero waste is an achievable objective on construction, demolition, and renovation sites	1	2	3	4	5	6
3. I am aware of recycling, reuse and salvage initiatives within the construction industry in my region	1	2	3	4	5	6
4. My customers/clients regularly request recycled, reused and salvaged building materials in their projects	1	2	3	4	5	6
5. Construction, renovation and demolition ‘waste’ materials are a valuable resource	1	2	3	4	5	6
6. Using reused and salvaged building materials is feasible on all construction and renovation sites	1	2	3	4	5	6
7. Recycling, reuse and/or salvage of waste materials should be done on every construction and renovation site regardless of project size	1	2	3	4	5	6
8. Residential renovation projects should be required to have a waste management plan	1	2	3	4	5	6
9. I have purchased used, salvaged and/or repurposed materials for a renovation project for my home	1	2	3	4	5	6

10. My company urges clients and customers to use salvaged and reclaimed building materials	1	2	3	4	5	6
11. Project owners, designers and builders should use recycled, reused, and salvaged materials whenever possible.	1	2	3	4	5	6
12. I am aware of construction materials recycling, reuse and salvage companies/organizations in my community	1	2	3	4	5	6
13. I have sold/given/donated/ materials to a construction materials recycling, salvage or reuse organization.	1	2	3	4	5	6
14. Markets for recycled, reused, and salvaged building materials need to be expanded.	1	2	3	4	5	6
15. Legislation and regulations should govern waste management on residential renovation sites	1	2	3	4	5	6
16. I (or my company) have disposed of recyclable or reusable construction, renovation or demolitions because I/we did not know what to do with them	1	2	3	4	5	6
17. 100% recyclable construction materials and products should be banned from landfill	1	2	3	4	5	6
18. Waste is an unavoidable and necessary consequence of construction and renovation	1	2	3	4	5	6
19. I have looked for used or salvaged residential construction or renovation materials through an online search engine or websites.	1	2	3	4	5	6
20. Do you think using salvaged and repurposed materials saves in overall project costs?	YES	NO				

Please share with us the following basic information about your professional life.

Your Profession _____

Your Industry _____

Completed surveys can be returned by email to joseph.earle@ryerson.ca
 Thank you for your participation. Your time and answers are greatly appreciated.

Appendix B: Structured Interview Questionnaire

Survey # _____ of _____

Date ____/____/____

Personal Profile of Respondent

1.1. What is your age?

- a) 18-24
- b) 25-34
- c) 35-44
- d) 45-54
- e) 55 +

1.2. What is your gender?

- a) Female
- b) Male

1.3. What is your level of education?

- a) Post graduate degree
- b) Undergraduate Degree
- c) College Diploma
- d) High school
- e) Trades/apprenticeship

1.3.1. Please briefly elaborate on your background – What are you educated in? or What is your trade?

1.4. Are you a homeowner?

1.4.1. Have you ever renovated your home?

1.4.2. Have you ever used recycled, reused, repurposed or salvaged building materials in your own renovations?

1.4.3. Have you ever given or donated renovation materials to recycling, reuse, or salvage companies?

1.5. Do you have experience working within the construction, renovation, and demolition or an industry that provides products and services to these markets? (This includes materials, manufacturing, policy, trades, retail)

- 1.5.1. If YES ... Briefly detail your experience
- 1.5.2. If NO ... Why not?
- 1.6. How long have you worked in your industry?
- 1.7. What is your role within your company/organization?
- 1.8. Is recycling, reuse and reclamation of construction, renovation and demolition materials important to you?
 - 1.8.1. Why or why not? (social, economic, environmental?)

Company Profile

- 1.9. What is the nature of the business/organization that you work for? (select all that apply)
 - a) Recycling
 - b) Salvage
 - c) Construction
 - d) Demolition
 - e) Reuse/repurposing of materials
 - f) Retail/sales
 - g) Other (Please specify)_____
 - 1.9.1. **(If more than one is selected)** Estimate what percentage of the business that is dedicated to each of your selections?
 - 1.9.2. Can you please describe exactly what the company does?
- 1.10. How long has the business/organization been in operation?
 - 1.10.1. At current location?
 - 1.10.2. How long has the company been focused primarily on the business described above?
- 1.11. Where is your company located?
 - 1.11.1. If multiple locations please list all locations
- 1.12. What is your service area? Select all that apply
 - a) Urban
 - b) Suburban
 - c) Rural

- 1.12.1. If more than one service area please quantify what percentage of your work for each area?
- 1.12.2. Does the waste coming from these areas differ?
- 1.13. Is the company/organization for profit or non-profit organization?
- 1.14. What is the number of employees at your company/organization?
 - a) 0-10
 - b) 11-25
 - c) 26-50
 - d) 50-100
 - e) More than 100
- 1.15. What are the main motivations/drivers for the company's role in the construction, renovation, demolition recycling, reuse, and reclamation market?
 - 1.15.1. Can you describe the core values of the company/organization? (mission statement, objectives, driving principles)
- 1.16. What other organizations are important to your company/organization?
 - 1.16.1. Why?
 - 1.16.2. Is your company a member of any waste or recycling associations?
 - 1.16.2.1. If so which ones? Why?
- 1.17. Is your company unique or innovative in how you manage/process construction, renovation and demolition materials?
 - 1.17.1. What solutions to CRD waste recycling, reuse and salvage does your company use or have your company developed?
 - 1.17.2. Who are your main competitors in your industry?
 - 1.17.2.1. Describe your competitor companies/organizations?
 - 1.17.2.1.1. How have your competitors responded to your innovative/sustainable business practices?

Materials Profile

- 1.18. I am going to give you one minute and I would like you to please name as many residential construction materials that you can think of that are recyclable or reusable?
- 1.19. What types of materials does your company handle/deal with the most?
- 1.20. What types of materials do you specialize in?

- 1.21. Which of the following types of construction projects do you seek/receive materials from?
- a) New construction
 - b) Renovation
 - c) Demolition
- 1.22. What sector do your materials typically come from? (select all that apply)
- a) Industrial
 - b) Commercial
 - c) Institutional
 - d) Residential
- 1.23. How does your company source or obtain your materials?
- 1.23.1. Do your company have a community of resources/materials providers?
- 1.23.2. Does your company collect/salvage your own materials?
- 1.23.2.1. Who does the salvage work?
 - 1.23.2.2. If so how far does your company travel to collect materials?
 - 1.23.2.3. How do you get these salvage opportunities?
- 1.24. What are the most easily recycled reused or salvaged residential building materials? Why?
- 1.25. What are the most difficult to recycle, reuse or salvage residential building materials? Why?
- 1.26. Do you ever find you are in need of certain construction or renovation materials/products?
- 1.26.1. Why are they needed? (select all that apply)
- a) Good seller? High demand?
 - b) Small supply
 - c) Difficult to obtain? rare
 - d) Competitive market
 - e) Easier to dispose than salvage
 - f) Other (Please specify)_____
- 1.26.2. Do you advertise for any particular materials?

- 1.26.2.1. Do these materials come to you or do you pick up/salvage particular materials?
 - 1.26.2.1.1. Probe for the process of product removal
- 1.27. What are some common barriers or limitations to people contributing 'waste materials' to recycling, reuse, repurposing and salvage companies?
 - 1.27.1. What has been done to overcome these barriers?
 - 1.27.2. What needs to be done to overcome these barriers?
- 1.28. How do people know about your company/organization/products?
 - 1.28.1. Where and how do you advertise?
- 1.29. In your opinion what are the benefits of recycling/reclamation/reuse?
 - 1.29.1. In your opinion, are there any materials disposed of that should be recycled, reused and reclaimed more often?
 - 1.29.1.1. Why?
- 1.30. In your opinion are there any negative aspects to recycling/reclamation/reuse?
 - 1.30.1. Are there any materials that are recycled, reused, reclaimed that should be disposed of?
 - 1.30.1.1. Why?
- 1.31. If you could change anything about the construction industry to reduce waste and increase recycling and reuse what would it be?
- 1.32. What are the barriers or limitations to getting the materials needed for your business?
- 1.33. What changes would improve your participation in the recycling/reclamation/reuse industry?
- 1.34. Do customers come looking for specific materials or just recycled, reused, and salvaged materials in general?
 - 1.34.1. What is the most common residential construction, renovation materials that you deal with?
- 1.35. How do you dispose of any unwanted materials that come into your possession?
Or How do you manage your waste products?

Market Information

- 1.36. In your opinion are people aware of the potential for reuse and recycling of construction materials?
- 1.36.1. No →What can/should be done about this?
- 1.36.2. How can awareness of this potential be achieved?
- 1.37. In your opinion does the construction industry take seriously waste minimization and recycling and reuse of building materials?
- 1.37.1. Why or why not?
- 1.37.2. In your opinion what more can be done to improve the markets for reused and recycled materials your company deals with?
- 1.38. What is the typical reaction to the reused or recycled products/services your company offers?
- 1.38.1. Elaborate (does enthusiaum lead to sales and increased customer relationships?)
- 1.38.1.1. Customer/client reaction?
- 1.38.1.2. Competition reaction?
- 1.38.2. Have you had any major breakthroughs with customers or partner companies that you can share? (Such as convincing them to use recycled and reused products instead of new)
- 1.38.2.1. How did this occur?
- 1.39. How large a role do residential renovation wastes play in your business?
- 1.40. What do you do with materials you receive?
- 1.40.1. Sell 'as is'
- 1.40.2. Make them into new products
- 1.40.3. Break them down into more basic components and sell these
- 1.40.4. Repair them for resale
- 1.41. Which of the following sectors do your customers/clients typically come from or service?
- a) Industrial
 - b) Commercial
 - c) Institutional
 - d) Residential

- 1.42. Are your customers/clients ...
- a) Individuals buying on their own behalf
 - b) Individuals/companies/organizations buying on behalf of others
 - c) Companies buying materials for a specific use
- 1.42.1. Please elaborate
- 1.43. Whose responsibility is it to improve recycling, reclamation, and reuse of construction materials within your community? Or within the province?
- 1.43.1. Private business?
 - 1.43.2. Individuals?
 - 1.43.3. Government through legislation?
- 1.44. In your opinion why do more homeowners not use more salvaged, reusable materials in their renovations?
- 1.45. Have green ratings systems such as LEED, Green Globes, or Living building challenge helped to change industry perceptions of waste minimization and reuse?
- 1.45.1. How/Why have they achieved this?
 - 1.45.2. Have these rating systems impacted your business? How/Why?
- 1.46. Do you think using salvaged and repurposed materials saves in overall project costs?
- 1.46.1. Why or why not?
- 1.47. What more can be done to improve the overall construction recycling/reclamation/reuse markets?
- 1.48. Is there anything else you feel you want to share about the construction, renovation, and demolition waste reuse and recycling?

That is all of the questions for the interview. Thank you for your time and efforts in answering this survey. Your participation is greatly appreciated.

Appendix C: Likert Survey Results

Residential renovation and demolition waste management is an important issue.

When asked for their level of agreement to the statement "Residential renovation and demolition waste management is an important issue" 95% of respondents strongly agreed or agreed. Only 2 respondents disagreed and 1 respondent was neutral neither agreeing nor disagreeing with this statement. This result indicates that a strong majority of construction professionals recognize the importance and impacts of the materials and resources that are commonly used within the CRD industry in Ontario. (See Table 1).

Table 1: Residential Renovation and Demolition Waste Management Is an Important Issue

Total	64	%
Strongly Agree	45	70%
Agree	16	25%
Neutral	1	2%
Disagree	0	0%
Strongly Disagree	2	3%
Not applicable	0	0%
No response	0	0%
	64	100.00%

Zero waste is an achievable objective on construction, demolition and renovation sites.

In response to the statement "zero waste is an achievable objective on all job sites" 22% of respondents strongly agreed, and 38% agreed that it was achievable. 27% disagreed and 2% strongly disagreed that zero waste was achievable objective for CRD sites. 11% took a neutral stance neither agreeing nor disagreeing. This demonstrates that although zero waste is an extremely challenging objective, a small majority of Ontario green building and waste management professionals feel that it is possible under current market conditions. (See Table 2).

Table 2: Zero Waste Is an Achievable Objective on Construction, Demolition and Renovation Sites

Total	64	%
Strongly Agree	14	22%
Agree	24	38%
Neutral	7	11%
Disagree	17	27%
Strongly Disagree	1	2%
Not applicable	0	0%
No response	1	2%
	64	100.00%

I am aware of recycling, reuse and salvage initiatives within the construction industry in my region.

Those surveyed indicated that they were well aware of recycling, reuse, and salvage initiatives in the construction industry in their regions. One quarter of respondents strongly agreed and another 41% agreed that they were aware of these initiatives within the construction industry. Surprisingly, 11% of respondents were not aware of recycling, reuse, or salvage initiatives within the construction industry. In total, 66% of respondents were at least somewhat aware of RRR opportunities within their construction communities, which is positive. Given that respondents were green building and waste management professionals, it is somewhat disturbing to see that a large percentage of respondents had little or no awareness of RRR initiatives within their communities. (See Table 3).

Table 3: I Am Aware Of Recycling, Reuse and Salvage Initiatives within the Construction Industry in My Region

Total	64	%
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Strongly Agree	16	25%
Agree	26	41%
Neutral	13	20%
Disagree	7	11%
Strongly Disagree	0	0%
Not applicable	2	3%
No response	0	0%
	64	100.00%

My customers or clients regularly request recycled reused or salvaged building materials in their projects.

When asked if their customers or clients regularly request recycled, reused or salvaged building materials, 13 % of respondents strongly agreed indicating that this was a request they commonly encountered, while a further 22% of respondents agreed with the statement. Almost one quarter (23%) of respondents disagreed with the statement, while 8% strongly disagreed indicating clients very rarely or never asks for UBMs on a consistent basis. Overall with more than 30% disagreeing to some extent and 35% agreeing this indicates a relatively even split amongst construction and waste management professionals getting requests for UBMs. This indicates an opportunity for leadership on the part of green building professionals to bring to the attention of clients opportunities they may not otherwise be aware of. (See Table 4).

Table 4: My Customers or Clients Regularly Request Recycled Reused or Salvaged Building Materials in Their Projects

Total	64	%
Strongly Agree	8	13%
Agree	14	22%
Neutral	12	19%

Disagree	15	23%
Strongly Disagree	5	8%
Not applicable	10	16%
No response	0	0%
	64	100.00%

Construction, renovation, and demolition waste materials are a valuable resource.

The statement “construction, renovation and demolition waste materials are a valuable resource” found 64% of respondents who strongly agreed and 33% who agreed. This means that more than 97% of respondents agreed that CRD waste materials are a valuable resource and indicates a strong understanding of the inherent value of the materials that the industry is regularly discarding. Not a single respondent disagreed with this statement which is somewhat surprising given the amount of waste that is generated on construction sites of all shapes and sizes every day across the province of Ontario. (See Table 5).

Table 5: Construction Renovation and Demolition Waste Materials Are a Valuable Resource

Total	64	%
Strongly Agree	41	64%
Agree	21	33%
Neutral	1	2%
Disagree	0	0%
Strongly Disagree	0	0%
Not applicable	1	2%
No response	0	0%
	64	100%

Using reused and salvaged building materials is feasible on all construction and renovation sites.

Almost 80% of respondents agreed to some extent with the statement “using reused and salvaged building materials is feasible on all construction and renovation sites.” 11% of respondents disagreed with the given statement indicating that it was not feasible on all construction and renovation sites. Along with those who remained neutral regarding this statement (13%), 24% of respondents do not think it is feasible to reuse or salvage on any job site. The strong level of agreement to this statement indicates that there is a definite awareness of what is possible but that there is a lack of willingness to initiate the reuse of materials within projects. (See Table 6).

Table 6: Using Reused and Salvaged Building Materials Is Feasible On All Construction and Renovation Sites

Total	64	%
Strongly Agree	24	38%
Agree	25	39%
Neutral	8	13%
Disagree	7	11%
Strongly Disagree	0	0%
Not applicable	0	0%
No response	0	0%
	64	

Recycling, reuse and/or salvage of waste materials should be done on every construction and renovation site regardless of project size.

More than half (55%) of respondents strongly agreed that regardless of project size recycling reuse and salvage should be done on every construction and renovation site. A further

38% of respondents agreed with the statement indicating that a strong majority of construction professionals in Ontario recognize a need for all projects to better manage their wastes. Only 3% of respondents disagreed that RRR should be done on projects of all sizes while 5% of respondents remained neutral. This result indicates that green building and waste management professionals believe that more should be done on all types of construction projects, in particular smaller projects where no waste management plans are required at this time. It also indicates a lack of leadership since respondents generally think it can and should be done, yet the broad industry is failing to do so, instead adopting a business as usual approach regarding waste management. (See Table 7).

Table 7: Recycling, Reuse and/or Salvage of Waste Materials Should Be Done on Every Construction and Renovation Site Regardless of Project Size

Total	64	%
Strongly Agree	35	55%
Agree	24	38%
Neutral	3	5%
Disagree	2	3%
Strongly Disagree	0	0%
Not applicable	0	0%
No response	0	0%
	64	

Residential renovation projects should be required to have a waste management plan.

When responding to the statement “residential renovation projects should be required to have a waste management plan” more than 83% of survey respondents agreed or strongly agreed. This indicates that respondents recognize residential waste as a major contributor to the CRD waste problem and that the small scale projects should be more responsibly managed much as

large projects are required. 11% of respondents remained neutral while 3% of respondents disagreed that residential renovation projects should have waste management plans. Mandating residential waste management plans would mean that individual homeowners and renovation contractors would be required to have greater accountability. They would have to at least consider what happens to their waste and to consider the alternative waste management options of RRR in order to reduce project impacts. (See Table 8).

Table 8: Residential Renovation Projects Should Be Required To Have a Waste Management Plan

Total	64	%
Strongly Agree	25	39%
Agree	29	45%
Neutral	7	11%
Disagree	2	3%
Strongly Disagree	0	0%
Not applicable	1	2%
No response	0	0%
	64	

I have purchased used, salvaged and or repurposed materials for a renovation project for my home.

More than half of respondents (52%) had purchased used, salvaged, or repurposed materials for a personal home renovation. Around 20% disagreed or remained neutral indicating they had not purchased these types of materials for a personal project. This could potentially contribute to a lack of awareness about where markets exist and how difficult to use salvaged materials are on job sites. This lack of participation in the markets shows that although

participants are aware of opportunities they are not taking advantage of them personally. (See Table 9).

Table 9: I Have Purchased Used, Salvaged And Or Repurposed Materials for a Renovation Project for My Home

Total	64	%
Strongly Agree	21	33%
Agree	12	19%
Neutral	7	11%
Disagree	5	8%
Strongly Disagree	2	3%
Not applicable	17	27%
No response	0	0
	64	

My company urges clients and customers to use salvaged and reclaimed building materials.

When asked if their companies urge clients to use salvaged and reclaimed building materials within projects 30% of respondents strongly agreed, while another 20% agreed. This 50% of respondents indicates that there are many companies actively urging and encouraging the use of these materials within projects. 22% of respondents chose neutral as their answer, neither agreeing nor disagreeing with the statement. 8% of respondents either disagreed or strongly disagreed with the statement indicating they were not actively urging this option with customers or clients. These responses demonstrates that half of green building and waste management companies are leading the way and providing customers with options they may not be aware of. However, there are still many others that are purely client driven in their demand for alternative materials and are not interested in the concept of reuse and salvage as defining factor in their

business model. 20% of respondents selected not applicable as their response indicating they did not feel this statement was relevant to the company that they worked for. (See Table 10).

Table 10: My Company Urges Clients and Customers to Use Salvaged and Reclaimed Building Materials

Total	64	%
Strongly Agree	19	30%
Agree	13	20%
Neutral	14	22%
Disagree	4	6%
Strongly Disagree	1	2%
Not applicable	13	20%
No response	0	0
	64	100%

Project owners, designers, and builders should use recycled, reused and salvaged materials whenever possible.

In response to the statement “project owners, designers, and builders should use recycled, reused and salvaged materials whenever possible” 44% of respondents strongly agreed. A further 38% agreed with this statement, for a total of 82% of respondents agreeing to some degree that more should be done about the use of RRR materials. This result indicates that participation in the use of UBM should be much higher than it is based on those surveyed. However, clients may dismiss the ideas of using these materials. This also indicates that more needs to be done to educate construction professionals about where to find RRR materials so they can actually reduce the amount of new materials they consume and increase the amount of reuse and recycling. (See Table 11).

Table 11: Project Owners, Designers, and Builders Should Use Recycled, Reused and Salvaged Materials Whenever Possible

Total	64	%
Strongly Agree	28	44%
Agree	24	38%
Neutral	8	13%
Disagree	1	2%
Strongly Disagree	0	0%
Not applicable	1	2%
No response	2	3%
	64	

I am aware of construction materials recycling, reuse and salvage companies/ organizations in my community.

Slightly more than 14% of respondents were not aware of any recycling, reuse, or salvage companies or organizations within their own community. Meanwhile, 62% of respondents agreed to some extent that they were aware of these companies or organizations in their communities. Given that these are people who operate within the construction and waste management industries on a day to day basis the large percentage of respondents who are not aware of these types of companies can be seen as a major issue. If green building and waste management professionals are not aware of these types of companies then the likelihood of individual homeowners who are undertaking a renovation knowing of them is probably low. This may show that lack of awareness is a major barrier affecting within the UBM markets. The response to this statement may also indicate that there is a lack of such facilities within the communities of the respondents and therefore it may not be purely an awareness issue. Overall, it

indicates that there is a need to grow the UBM retail industry itself and also the awareness of all those involved in the handling of CRD materials. (See Table 12).

Table 12: I Am Aware of Construction Materials Recycling, Reuse and Salvage Companies/Organizations in My Community

Total	64	%
Strongly Agree	9	14%
Agree	31	48%
Neutral	12	19%
Disagree	9	14%
Strongly Disagree	0	0%
Not applicable	1	2%
No response	2	3%
	64	

I have sold/given/donated materials to a construction materials recycling, salvage or reuse organization.

More than 50% of respondents agreed to some extent that they had sold, given, or donated materials to a construction recycling, salvage or reuse organization. Slightly more than 20% of respondents disagreed or strongly disagreed with the statement and have never given or donated materials to this type of organization. Lack of participation by individuals with knowledge of these markets is a barrier. It means that either facilities are not available or that people are not willing to take materials to locations that deal in UBMs. Through participation and continued contributions awareness can grow. People will tell friends, family, and neighbours about experiences with donating as well as purchasing of used materials which will increase the awareness. (See Table 13).

Table 13: I Have Sold/Given/Donated Materials to a Construction Materials Recycling, Salvage or Reuse Organization

Total	64	%
Strongly Agree	17	27%
Agree	15	23%
Neutral	7	11%
Disagree	10	16%
Strongly Disagree	3	5%
Not applicable	10	16%
No response	2	3%
	64	

Markets for recycled, reused, and salvaged building materials need to be expanded.

When presented with the statement “markets for recycled, reused and salvaged building materials need to be expanded” 67% of respondents strongly agreed, and 28% agreed. This meant that 95 % of respondents thought more needs to be done to expand the markets for UBMs. Not a single respondent disagreed to any extent with this statement. There is clearly a strong desire by green building and waste management professionals to improve their use of materials. However, the lack of developed markets in some areas of Ontario hinders participation. Although a large portion of respondents had neither participated in markets as sellers or as buyers of materials there was strong agreement these markets should be expanded. Residential renovations offer an excellent opportunity to grow these markets because small quantities of materials are needed and the work is often done by non-professionals. Professionals operating as renovators can expand the market by using these products and materials regardless of whether a client is requesting them. (See Table 14).

Table 14: Markets for Recycled, Reused and Salvaged Building Materials Need To Be Expanded

Total	64	%
Strongly Agree	43	67%
Agree	18	28%
Neutral	1	2%
Disagree	0	0%
Strongly Disagree	0	0%
Not applicable	0	0%
No response	2	3%
	64	

Legislation and regulations should govern waste management on residential renovation sites.

Over one third of respondents (36%) strongly agree that legislation and regulation should govern waste management on residential renovation sites. Another 42% agreed with this idea as well. Only about 8% of respondents disagreed to any extent. This means that there is strong support amongst respondents to make waste management on residential renovation job sites mandatory. (See Table 15).

Table 15: Legislation and Regulations Should Govern Waste Management on Residential Renovation Sites

Total	64	%
Strongly Agree	23	36%
Agree	27	42%
Neutral	5	8%
Disagree	4	6%
Strongly Disagree	1	2%
Not applicable	1	2%

No response	3	5%
	64	

I (or my company) have disposed of recyclable or reusable construction, renovation, or demolition materials because I/we did not know what to do with them.

About half (48%) of respondents indicated that either they personally or their company had disposed of recyclable or reusable construction, renovation, or demolition materials because they did not know what to do with them. This indicates either a massive lack of knowledge within the industry about how to deal with materials or a lack of recycling and reuse facilities within Ontario communities. 17% disagreed with the statement, and along with the 6% who strongly disagreed, had found places to reuse or recycle materials seemingly even if it meant putting in extra effort to find these types of opportunities. (See Table 16).

Table 16: I (or My Company) Have Disposed Of Recyclable or Reusable Construction, Renovation, or Demolition Materials Because I/We Did Not Know What to Do With Them

Total	64	%
Strongly Agree	13	20%
Agree	18	28%
Neutral	7	11%
Disagree	11	17%
Strongly Disagree	4	6%
Not applicable	8	13
No response	3	5%

100% recyclable construction materials and products should be banned from landfill.

The statement “100% recyclable construction materials and products should be banned from landfill” was broadly agreed upon by respondents. 85% of respondents agreed or strongly

agreed with the statement. Only 2% of respondents disagreed with the idea of banning these materials from landfill while 6% remained neutral. (See Table 17).

Table 17: 100% Recyclable Construction Materials and Products Should Be Banned From Landfill

Total	64	%
Strongly Agree	28	44%
Agree	26	41%
Neutral	4	6%
Disagree	1	2%
Strongly Disagree	0	0%
Not applicable	2	3%
No response	3	5%
	64	

Waste is an unavoidable and necessary consequence of construction and renovation.

The idea that waste is unavoidable and necessary consequence of construction activities garnered a divided response with 8% strongly agreeing, 27% agreeing. 25% disagreed that it was unavoidable and 14% strongly disagreed. This indicates that there are many who believe waste cannot be avoided at any costs while there are others who think that with appropriate measures taken on any project that waste can be kept to an absolute minimum. This result is split nearly 50/50 with those who agree and disagree. (See Table 18).

Table 18: Waste Is an Unavoidable and Necessary Consequence of Construction and Renovation

Total	64	%
Strongly Agree	5	8%
Agree	17	27%
Neutral	12	19%
Disagree	17	27%

Strongly Disagree	9	14%
Not applicable	1	2%
No response	3	5%
	64	

I have looked for used or salvaged residential construction materials through an online search engine or website.

When asked if they had searched for used or salvaged residential construction materials through an online search engine or website respondents were divided. 45% of all respondents either agreed or strongly agreed that they had searched online for materials. Meanwhile, 17% of those surveyed disagreed and 8% strongly disagreed that they had done so. Searching for UBMs was not applicable to 14% of respondents. Overall, this response indicates that if green building or waste management professionals are looking for materials the majority of them will use online resources at some point during their search. Those who did not search online may not be aware that such an option exists. (See Table 19).

Table 19: I Have Looked For Used or Salvaged Residential Construction Materials through an Online Search Engine or Website

Total	64	%
Strongly Agree	14	22%
Agree	15	23%
Neutral	8	13%
Disagree	11	17%
Strongly Disagree	5	8%
Not applicable	9	14%
No response	2	3%

Do you think using salvaged and repurposed materials saves in overall project costs?

When asked whether using salvaged and repurposed materials saves in overall project costs 58% of respondents said that it does save project costs. Only 38% disagreed, indicating that costs would be higher or on par with new material costs. This is a surprising result given that this number of people believes it saves yet they do not urge their customers or clients to regularly use these types of materials. (See Table 20).

Table 20: Do You Think Using Salvaged and Repurposed Materials Saves In Overall Project Costs?

Total	64	%
Yes	37	58%
No	24	38%
no response	3	5%

Table 21: Profession of Respondent

Total	64	%
Carpenter/contractor	9	14%
Architect/designer	14	22%
Consultant	7	11%
Engineer	3	5%
Unspecified	10	16%
Materials sales/retail/marketing	8	13%
Executive director/management	3	5%
Estimator	1	2%
Compliance officer/project manager/waste diversion officer	3	5%
Other	5	8%
Professor/educator	1	2%
	64	

Table 22: Industry of Respondent

Total	64	%
Construction-residential	11	17%
Architecture	8	13%
Heritage	1	2%
Construction – ICI	12	19%
Unspecified	9	14%
Waste management	5	8%
Materials/sales/architectural salvage	7	11%
Government	4	6%
Ngo/non-profit/community based organization	1	2%
Education	2	3%
Building science	1	2%
Building operations/property management	3	5%
	64	