AN INVESTIGATION INTO ATTITUDES TOWARDS RECYCLING CCA TREATED LUMBER

by

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Abstract

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This research examines the effects of evaluations, beliefs, subjective norms, and perceived behavioral control on the contractor's decision intention to recover used CCA lumber. The purpose of this research was to determine the factors that affect recovery. This research proposes that a contractor's decision intention to recover is affected by evaluations, beliefs, subjective norms, and perceived barriers to recovery.

The study included a mail questionnaire that was sent to over 2,800 contractors. The questionnaire was used to collect both demographic data and an evaluation of the factors believed to affect the recovery of CCA treated lumber. Data was collected primarily through the mail survey, where participants rated the factors believed to affect the recovery of spent CCA lumber.

Extrapolation indicates that nearly 2.4 million cubic meters of treated lumber were removed in 1999 from the demolition of decks. It was also discerned that only two of the respondents recovered used CCA lumber on a full-time basis. Additionally, there appears to be a lack of knowledge regarding the chemical components of CCA treated lumber, the proper disposal methods, and handling of the product. This has profound strategic implications for not only the wood treating industry but other industries as well.

The second phase of the research utilized ordinary least squares regression and a structural equation modeling program to model the factors concerning the contractors' decision intention to recover. The findings indicate that contractor beliefs and components of perceived behavioral control are the primary drivers in the contractor's decision intention to recover. Regarding beliefs, the findings indicate that contractors have a minimal belief that the recovery of the CCA lumber is necessary. This indicates that a marketing communications program should be developed to address the necessity and benefits of recovery.

Recovery facilities and programs were found to be nonexistent and will have to be developed in order to facilitate recovery. Concerning programs, the overwhelming response was that some type of financial incentive would have to be incorporated to initiate recovery. In conjunction with the development of programs, recovery facilities will have to be developed that are convenient for the contractor to dispose of the used lumber.

DEDICATION

This study is dedicated to my parents, Mary and Delton Alderman, Sr., who have given their love and have supported my efforts continually. And to my sister, Susan and her husband Rick, and my two nephews, Morgan and Lucas, a special thanks to all of you.

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Blessed be the name of God forever and ever,
For wisdom and might are His. . . .
He gives wisdom to the wise
And knowledge to those who have understanding.
He reveals deep and secret things;
He knows what is in the darkness,
And light dwells with Him

Daniel 2:20 - 22

PREFACE

This dissertation is comprised of six chapters. Chapter 1 defines the problem, organizes the objectives to address the problem, and reviews the literature relevant to the research. Chapter 2 describes the theory of planned behavior and addresses recycling from a marketing perspective. Chapter 3 describes the methods and results of the mail survey, and examines the decking industry from selected states in the Southeastern United States. Chapter 4 examines the modeling of attitudes towards the recovery of used CCA lumber in regards to contractors. Chapter 5 profiles recovery from the perspectives of state and local waste management officials, landfill managers, building inspectors, and contractors. Finally, Chapter 6 summarizes the overall findings and presents a personal perspective for the recovery of used CCA lumber.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE. An Overview of CCA Treated Lumber And Recycling

Introduction

As the markets for and production of wood products increase each year, the quantity of wood products reaching the end of their useful life increases as well. As an example, the production and utilization of chromated copper arsenate (CCA) treated lumber has shown substantial growth since the 1970's. As a result, several investigators predict that the quantities of used CCA treated lumber will increase significantly in the upcoming decades (Cooper, 1993; Stalker, 1993; Felton & DeGroot, 1996; and McQueen & Stevens, 1998).

The awareness and concern regarding the environmental impacts and disposal of treated wood products are also increasing. In order to meet the current and future demand for treated forest products, the wood products industry must proceed in at least two areas. First, the recovery of, the recycling of, and utilization of used CCA treated wood products removed from service must be incorporated into our current usage of wood products. The utilization of used CCA treated wood products will entail the development of new manufacturing processes, manufacturing recovered lumber into new products, or alternative applications. The utilization of spent and recycled CCA lumber may reduce the demand on both our private and public softwood forests. This is critical as American citizens and manufacturers produce over 510 million cubic meters of wood and forest products each year (Haygreen & Boyer, 1996). From another perspective, the weight of wood and forest products used each year (in the United States) is nearly equal to the weight of *all* metals, plastics, and Portland cement combined (Boyer, 1992). Additionally, this will reduce the demand placed on both our public and private landfills.

Secondly, both the forest products and lumber treating industries should endeavor to become leaders in the development and establishment of recovery and recycling programs, and in the development of new or remanufactured products. Current forest products industry practices (with the exception of the paper and pallet segments) appear to be on a cursory level regarding the development of sustainable recycling programs and the development of new products or applications.

At present it appears that all major industries are now actively promoting the recycling of their products. These industries were confronted with similar product-recycling issues, as does the CCA treated lumber industry. These problems include increasing production and consumption, increasing quantities of spent products entering the waste stream, decreasing numbers of landfills, increasing tipping fees, the threat of potential governmental action, possible negative public reactions, negative attitudes towards the disposal of those products, and environmental concerns (e.g., leaching, toxicity, and the utilization of real estate for landfills).

Let us review two different industries that face similar problems, as does the CCA treated wood industry. It should also be noted that these industries are direct competitors with the forest products industry.

First, the number of plastics companies handling and reclaiming post-consumer plastics has grown nearly six times in the last thirteen years (from 300 facilities in 1986 to 1,792 in 1998). The plastics recycling industry is considered as being in the growth stage of the industry life cycle. Market demand and recycling capacity (to process plastic resin) exceed the quantities of plastics being recovered. For example, in 1998, 1.45 billion pounds of plastic bottles were recycled as compared to 6.18 billion pounds sold. The current recycling rate for plastic bottles is nearly 24 percent (Plastics Resource, 1999).

Plastics Resource (1999) also estimates that 19,200 communities in the United States (or approximately 75 percent of American citizens) have access to plastics recycling programs. They state that to achieve cost effectiveness, the industry will have to renew their effort(s) in educating the public, plastics collectors, material recovery facility operators, and processors in order for plastics recycling to grow. For example, the American Plastics Council undertakes projects that include industry stakeholders (e.g., original manufacturers), universities, and government agencies to address the challenges and opportunities regarding economically sustainable and environmentally sound recovery of plastics (American Plastics Council, 1999).

Secondly, the American Iron and Steel Institute (AISI) (1999) reports that nearly 61 percent of the steel cans produced in 1998, 81 percent of appliances taken out of service in 1998, and 92 percent (13 million) of 1998's automobiles (taken off the road in 1998) were recycled in 1998. The recovery of steel cans has been estimated to have grown more than 400 percent since 1988.

The AISI states that more than 200 million American citizens have access to community or company recycling programs and that during the past decade the infrastructure for and consumer awareness of steel recycling has seen tremendous growth. These programs include curbside drop-off and pickups and buyback programs. Additionally, the Steel Recycling Institute (1999) reports that the steel industry's dependence upon scrap metal is driving the development of new recycling programs and markets for steel.

All of the aforementioned industries actively promote recycling, have extensive web sites regarding their particular industry, participate in recycling research, and some are actively involved with local communities in the development of recycling programs.

Regarding the forest products industry, Araman *et al*. (1996) estimated that nearly 185 million wood pallets were directed to municipal solid waste landfills in 1995. Of this total, it was estimated that 7.4 million tons of pallet material were landfilled in the United States. In addition, they estimated that nearly 881 thousand tons of the wood and yard residues recovered in 1995 were pallet residues. Approximately 4.2 million tons of pallets were recycled or an 11.9 percent recovery/recycle rate.

The introduction has revealed that increasing quantities of CCA treated lumber are going to be being taken out of service. Only by gaining knowledge of attitudes toward the recovery of spent CCA treated lumber, current programs, facilities, barriers to recovery, and developing estimates of CCA treated lumber taken out of service can we as an industry develop programs, aid in facility establishment, new products and associated industries, or applications to prevent these available resources from being wasted.

Problem Statement

Recent research regarding the quantities of preservative treated lumber taken out of service indicates that there is a pressing need to determine the factors affecting the recovery, recycling of, and the subsequent utilization of used CCA treated lumber. However, the major caveat is a fundamental lack of knowledge regarding those pertinent factors associated with the removal, recovery, and recycling of CCA treated lumber, as these factors are not well understood.

These factors must be identified and researched in order to affect the recovery and recycling of CCA treated lumber. First, basic demographic data must be collected that will allow the determination of the typical applications of treated lumber. Secondly, this information will allow the opportunity to categorize the applications, quantities, and condition of the lumber being taken out of service. Another aspect will be to discover if spent CCA lumber is a major problem. Of these, one of the more important findings will be determining the quantities and conditions of the CCA treated lumber being taken out of service. Without this basic information, we will not be able to suggest programs, potential applications, or markets for recycled lumber. We may find that there are inadequate quantities available or that the lumber removed from service is not suitable for reuse in the capacity from which it was removed or for other products. Additionally, the methods of deconstruction and disposal will be discerned.

Existing recycling centers for CCA lumber will be identified if they exist, and if the numbers of these centers are determined insufficient or nonexistent, we can make recommendations regarding the establishment of recovery and recycling centers.

There may be barriers towards recovery, recycling, or utilizing used CCA treated lumber that could affect this process and this research will allow us to discern these barriers. Barriers typically include governmental policy, physical constraints, time, distribution centers, worker experience and skill, recycling or lack of recycling programs, knowledge of recycling programs, and costs (e.g., labor, disposal, and transportation).

Determination of factors will allow us the opportunity to gain insight into attitude determinants that influence attitudes toward the recycling of used lumber and ultimately the utilization of used CCA treated lumber. Attitude and recognition are generally regarded as the two constructs that comprise perception and recognition is simply the ability to recall an attitude object. There is now general agreement that humans have two types of attitude, attitude toward a behavior and attitude toward an object. Therefore, attitude is generally considered to be a person's degree of favorableness or unfavorableness towards an object and these are assessed in terms as the overall evaluation of the attitude object.

Results will yield insights into the attitudes contractors hold toward recycling spent CCA treated lumber. With the knowledge gained regarding those attitudes, persons who develop recycling programs for used CCA treated lumber will be able to develop the appropriate marketing strategies and tactics to increase recycling.

Why do we want to recover and recycle? From a global perspective, to better utilize the fruits of both our private and national forests. Additionally, there is the potential for new environmental regulations being enacted that may prohibit the disposal and storage of spent CCA treated lumber in all landfill types. As the number of landfills decrease, with landfill tipping fees increasing, and limitations being placed on the types of materials which can be landfilled, it is vital that used CCA treated wood lumber currently directed to landfills be recovered and recycled. Ultimately the recovery and recycling of used CCA treated lumber will have an affect in five principal areas: 1) conservation of both public and private softwood forests and extend the life of our natural resources, 2) reducing the area of public and private land utilized for landfills, 3) reduce the demand on the nation's landfills, 4) enhance manufacturing profitability, and 5) new economic opportunities via the creation of recycling businesses.

Goals and Objectives

The primary goal of this research was to identify the factors that will assist decision-making in reducing the quantities of CCA treated lumber directed to private and public landfills.

1. Categorize and quantify Southern yellow pine CCA treated lumber being taken out of service from residential decks (in NC, SC, and GA). From this information national estimates of decking lumber being taken out of service will be developed.
2. Identify attitudes, beliefs, barriers, and incentives towards the recovery and/or initiation of recycling used CCA treated lumber.
3. Develop marketing strategies and tactics for the recovery and recycling of used CCA treated lumber.

Literature Review

Background

CCA Manufacturing Processes and Treated Wood Production

Natural organisms and the chemical structure of wood necessitate that wood products undergo preservative treatments in order to prevent degradation – principally biological degradation. Wood products are chemically treated primarily to prevent attacks from numerous fungi and insects.

In the Central and Eastern United States, the Southern yellow pine group is the most commonly preservative treated species group. The primary chemicals used in this process are copper oxide (20 percent), chromium trioxide (35 – 60 percent), and arsenic pentoxide (15 – 45 percent), and these three chemicals are used to form Chromated Copper Arsenate (American Wood Preservers' Association (AWPA), 1990). Copper and arsenic are considered broad-spectrum fungicides, arsenic also provides for insect protection, and chromium trioxide's affinity for wood lignin provides a bond that limits the leaching of the preservative from the wood structure (Zabel, 1992).

An aqueous solution is used as the transport agent to introduce the preservative compound into the wood structures. Chemicals are typically introduced into wood via a pressure treatment process, in which the preservative is forced (under pressure) into wood's cellular structure (while the wood is in a pressured cylinder), (American Wood Preservers' Institute (AWPI), 1999).

CCA treated Southern yellow pine products are typically used in outdoor applications, primarily for residential decks. However, a variety of products are manufactured, and they include fence posts, landscape timbers, lattice, railings, deco turnings, posts, and a limited number of utility poles (Kamden & Munson, 1996). AWPI (1996) research estimated that nearly 451 million cubic feet of lumber were treated with CCA preservatives in 1995, of which nearly 79 percent was utilized in the Southern United States.

The Southern Forest Products Association (1999) estimated that the demand for treated Southern yellow pine (SYP) lumber was 5.48 billion board feet in 1997. Of this total, nearly 659 million board feet of treated lumber was utilized in new residential decking, and 1.46 billion board feet was consumed for the repair or remodeling of residential decks (Table 1.1).

Estimates of CCA Treated Wood Quantity Removal and Current Uses

There are wide discrepancies in the estimates of treated wood quantities taken out of service. Cooper (1993) estimated that in 1990 nearly eight million cubic meters of treated lumber were removed from service. For the year 2000, Cooper estimated nine million cubic meters, in 2010 nearly 15 million cubic meters, and 2020 eighteen million cubic meters will be removed from service. Felton and DeGroot (1996) estimated that nearly six million cubic meters (1996) and in 2020 nineteen million cubic meters will be removed. In between those estimates, McQueen and Stevens (1998) projected that in 1997 nearly ten million cubic meters were removed and in 2004 nearly twelve million cubic meters will be removed from service.

The construction and remodeling of residential decking is estimated to consume the largest quantity of CCA treated Southern yellow pine (SYP). The Southern Forest Products Association (SFPA) (1999) estimates that over two billion board feet (37.6 percent) is utilized in the construction, repair, and remodeling of residential decks in 2000. They also estimate that an average of 2,054 billion board feet was/will be utilized for decking and 5,466 billion board feet of southern yellow pine per year will be preservative treated during the 1997 to 2004 time frame.

Table 1.1. SFPA Estimates of CCA Treated Southern Yellow Pine - 1999 (in million board feet).

Major Market	Estimates by Year							
Residential	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Floor framing	39.8	41.4	44.4	37.8	40.0	35.8	31.7	41.0
Wall framing	68.4	73.2	79.4	67.7	72.4	66.2	60.1	76.9
Roof framing	15.3	14.9	16.3	14.1	15.2	14.0	12.6	16.0
Trusses	19.9	19.0	20.4	17.9	19.2	17.6	15.9	20.4
New decks	658.7	721.7	731.9	651.7	693.1	626.0	574.6	742.8
Wood foundations	83.2	93.8	93.8	84.7	89.7	80.2	74.3	96.9
Subtotal	**885.2**	**964.0**	**986.2**	**873.9**	**929.5**	**839.7**	**769.2**	**994.0**
Non-Residential								
Floor framing	5.4	5.7	5.6	5.2	5.5	5.8	5.2	5.0
Wall framing	3.4	3.8	3.8	3.5	3.7	4.1	3.8	3.6
Roof framing	6.1	6.3	6.3	5.9	6.3	6.9	6.5	6.1
Trusses	16.4	16.3	16.1	15.3	16.3	17.8	16.6	15.7
Glulam	4.5	5.4	5.1	4.9	5.2	5.7	5.4	5.0
Subtotal	**35.9**	**37.5**	**36.8**	**34.7**	**37.1**	**40.4**	**37.4**	**35.3**
Agricultural								
Posts	59.0	67.6	62.7	61.0	63.3	67.3	64.6	60.6
Miscellaneous framing	4.9	5.6	5.2	5.0	5.2	5.5	5.3	5.0
Subtotal	**63.9**	**73.2**	**67.9**	**66.0**	**68.5**	**72.8**	**69.9**	**65.5**
All Construction Markets								
Subtotal	**985.0**	**1,074.7**	**1,090.9**	**974.6**	**1,035.1**	**953.0**	**876.6**	**1,094.8**
Industrial								
Material handling	194.8	195.5	205.1	204.1	210.3	219.0	225.5	228.7
Marine	689.8	820.2	771.5	744.7	796.3	871.8	814.6	766.3
Highway	576.0	684.9	644.3	621.9	665.0	728.0	680.2	639.9
Furniture	4.4	4.2	4.4	4.4	4.4	4.5	4.4	4.4
Subtotal	**1,465.0**	**1,704.9**	**1,625.30**	**1,575.0**	**1,676.1**	**1,823.3**	**1,724.7**	**1,639.3**
Repair & Remodeling								
Room additions	30.6	28.5	28.7	28.5	30.2	30.8	28.5	28.4
Attached garages	5.1	4.8	4.8	4.8	5.0	5.1	4.8	4.7
Finish basements	4.5	4.3	4.3	4.3	4.5	4.6	4.3	4.3
Decks	1,465.5	1,338.3	1,359.0	1,339.7	1,415.4	1,445.3	1,336.0	1,332.2
Miscellaneous home projects	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.1
Remodel kitchen/bath	4.2	4.0	4.0	4.0	4.2	4.3	4.0	4.0
Subtotal	**1,510.1**	**1,381.0**	**1,401.9**	**1,382.4**	**1,460.5**	**1,491.4**	**1,378.7**	**1,374.7**
Additions/Alterations Separate from Structures								
Fences	562.9	484.0	435.2	407.6	430.6	439.8	406.8	405.6
Sheds	13.8	12.9	13	12.9	13.6	13.9	12.9	12.8
Landscaping	836.9	788.2	792.4	789	833.6	851.2	786.8	784.6
Detached garage	6.0	5.6	5.7	5.6	5.9	6.1	5.6	5.6
Miscellaneous home projects	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.8
Subtotal	**1,420.6**	**1,291.5**	**1,247.0**	**1,216.0**	**1,284.7**	**1,311.9**	**1,213.0**	**1,209.4**
Major Replacements								
Re-roof	1.6	1.5	1.5	1.5	1.6	1.6	1.5	1.5
Subtotal	**1.6**	**1.5**	**1.5**	**1.5**	**1.6**	**1.6**	**1.5**	**1.5**
Maintenance/Repairs								
Miscellaneous home projects	9.8	9.4	9.4	9.4	9.9	10.1	9.4	9.3
Subtotal	**9.8**	**9.4**	**9.4**	**9.4**	**9.9**	**10.1**	**9.4**	**9.3**
Total R/R Markets								
Subtotal	**2,942.0**	**2,683.4**	**2,659.9**	**2,609.3**	**2,756.7**	**2,815.1**	**2,602.5**	**2,595.0**
Export	94.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3
Subtotal	**94.3**	**93.3**	**93.3**	**93.3**	**93.3**	**93.3**	**93.3**	**93.3**
Grand Total	**5,486.2**	**5,556.2**	**5,469.4**	**5,252.2**	**5,561.1**	**5,684.6**	**5,297.1**	**5,422.4**

Source: Southern Forest Products Association, 1999.

The other major uses of CCA treated SYP are in the industrial markets (e.g., material handling, marine, highway, and furniture applications), which are estimated to consume about thirteen billion board feet or 30.3 percent of CCA treated SYP lumber production in the same time period. Additions and alterations separate from a structure (e.g., fences, sheds, landscaping, detached garages, miscellaneous home projects) are projected to utilize about ten billion board feet (23.3 percent), residential construction will consume over 1.8 billion board feet (4.2 percent) in the 1997 to 2004 time frame. The remaining quantities are used in non-residential, agricultural, repair and remodeling, major replacements, maintenance and repair applications, and for the export markets (Table 1.1).

Several studies have been conducted regarding the removal of CCA treated lumber and its potential uses (e.g, Webb & Davis, 1994; Schmidt *et al*., 1994; Vick *et al*., 1996; Smith & Shiau, 1996; Felton & DeGroot, 1996; Avellar & Glassar, 1998; and McQueen & Stevens, 1998). These studies focused on the potential markets and products that could be manufactured from recovered CCA treated wood (e.g., particleboard, reconstituted railroad ties, steam explosion processing, and barriers to recycling).

Recycling

Globally, nationally, and at local levels, solid residue quantities are increasing. Correspondingly, awareness and concern for residue disposal is also increasing. Bede and Blom (1995) project that global solid residue quantities will increase at an annual rate of 2.4 percent through the year 2019.

In light of this, during the 1990's the objective of many national residue strategies was to make residue management more sustainable. The first priority is to avoid residue production (Figure 1.1), followed by minimization of quantities, then reuse or recycle as much as practical, and next is treatment (which focuses on the recovery of energy and minimization of quantities requiring final disposal). Finally, residues are landfilled (Environmental Resources Management, 1992). This sequence is known as the European Union Waste Management Hierarchy.

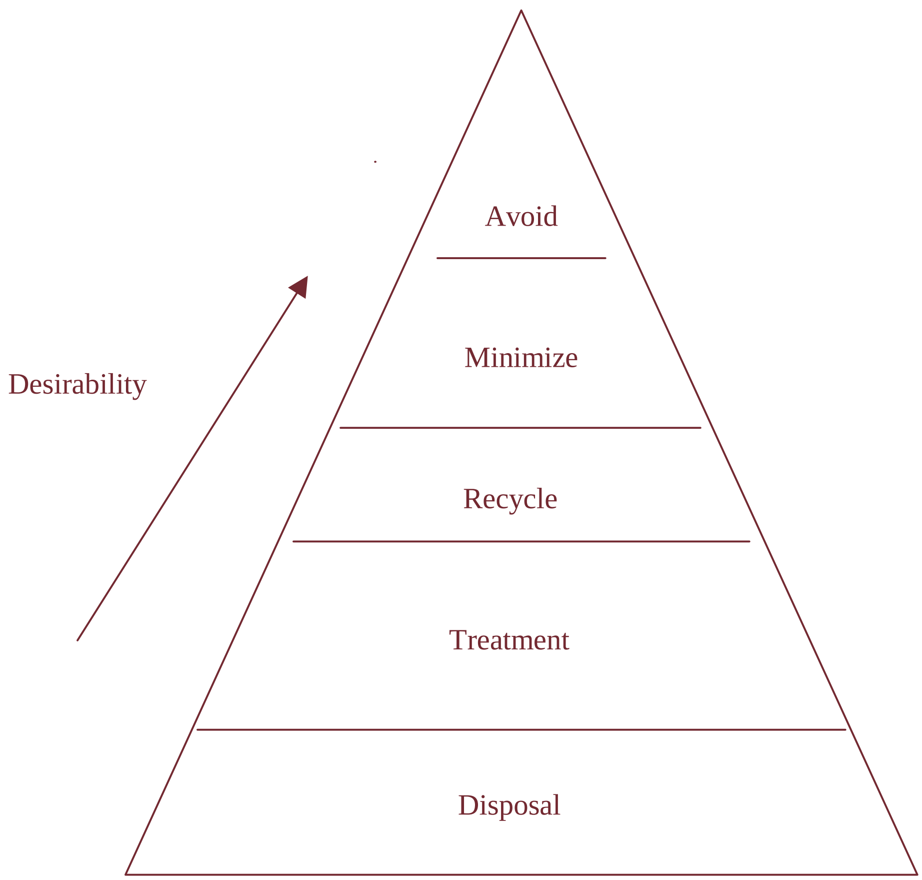

Figure 1.1. The Residue Management Hierarchy.
Source: Environmental Resources Management© (1992).

Since this program was devised (in the late 1970's) the majority of European Union member countries still landfill and incinerate residues (Wilson, 1996). Wilson posits two factors as to why landfilling dominates residue management:

1) It *appears* to be the cheapest option. This is due in part because the existing "free residue disposal" market is a distortion in itself, whereby the residue producer pays only a portion of disposal fees, society, in essence pays a subsidy for the majority of residue disposal through taxation;

2) Currently it makes little sense for manufacturers or consumers to spend money on residue prevention, minimization, or recycling in order to reduce the quantities of post-consumer residues, because it is believed that consumers would be increasing their costs for benefits not perceived.

He also states that a concerted move away from landfilling (Step 5), up the residue management hierarchy, will require a fundamental change in behavior by manufacturers, commerce, governments, and individual consumers. In addition, Wilson believes that the most obvious economic incentive for residue reduction is for the residue producer to directly pay the full costs of collection, treatment, and disposal of the residues they produce (in proportion to the actual quantity of the product produced).

Municipalities traditionally have disposed of residues by incineration or landfilling. Certain municipalities now ship their residues to other countries or states. Increasing disposal costs and tipping fees, public opposition, and environmental concerns are rendering these methods undesirable as long-term disposal options (Tilman & Sandhu, 1998).

In the United States the number of landfills operating is declining, from an estimated 3,100 in 1996 to 2,514 in 1997 (Glenn, 1998). The decline in landfill facilities is due in part to increased federal and state residue reduction legislation. Additionally, numerous landfills have reached capacity. These initiatives may restrict the types of materials that can be landfilled, restrict incineration of residues, and new landfill construction is subject to stricter and more expensive engineering requirements. For example, the United States Presidential Executive Order 12873 for Federal Acquisition, Recycling, and Residues Prevention, includes a section that states “when developing plans, drawings, specifications or other product descriptions, agencies shall consider the following factors: elimination of virgin material requirements; use of recovered materials; reuse of product; life cycle cost; recyclability; use of environmentally preferable products; residues prevention; and ultimate disposal as appropriate.” These requirements apply to newly written and existing specifications (BioCycle, 1998).

Potential external effects from landfill residues range from environmental toxicity to accumulation of long-term hazardous substances and increased concern of storage or disposal. Typical end treatments, such as landfilling and incineration, may result in toxic pollutant emissions and seepage from disposal sites. Many areas lack suitable landfill sites due to increased population and geologic conditions. In addition, landfills may consume productive agricultural land (Bruvoll, 1998).

Internationally, the Government of Japan is considering the enactment of stringent housing deconstruction regulations. It will require that timbers, lumber, glass, and other products are recovered for recycling. This legislation would place recycling costs on the new homeowner and require them to submit deconstruction and recovery plans to the proper authorities (Hersch, 1999).

Grogan (1998) reports that the University of North Carolina – Chapel Hill recently hired a professor of “reverse logistics.” The discipline relates to reacquiring products back from consumers and then remanufacturing them. Reverse logistics is reportedly a profound concept not only as it relates to recovery but to the United States’ general economy as well.

The United States Environmental Protection Agency (EPA) (1998) defines construction and demolition residues as residues produced in the process of construction, renovation, or demolition of structures (Table 1.2).

Table 1.2. Materials and Components Resulting from C&D Activities.

Material	Examples of Components
Wood	Forming and framing lumber, plywood, laminates, scraps, and stumps
Drywall	Sheetrock, gypsum, and plaster
Metals	Pipes, rebar, flashing, steel, aluminum, copper, brass, and stainless steel
Plastics	Vinyl siding, doors, windows, floor tile, and pipes
Roofing	Asphalt and wood shingles, slate, tile, and roofing felt
Brick	Bricks and decorative blocks
Glass	Windows, mirrors, and lights
Miscellaneous	Carpeting, fixtures, insulation, and ceramic tile

Source: EPA (1998).

Current Construction and Demolition Residue Regulation

Three types of residue legislative initiatives are prominent in the United States:

1. Mandating local governments to source separate and recycle specific materials;
2. Mandating local governments to provide recycling services. However this initiative type does not require mandatory recycling by companies or the public;
3. Residue reduction legislation, where local governments must attain prescribed residue reduction goals by developing recycling programs or by instituting mandatory ordinances (Glenn & Riggle, 1991).

The EPA (1998) reports that there are four common regulatory schemes being utilized by states for construction and demolition residue(s). The schemes are as follows:

1) Construction and demolition must meet municipal solid waste landfill requirements (11 states),
2) Construction and demolition residues are regulated separately (24 states),
3) Separate requirements for on-site and off-site construction and demolition landfills (8 states) and,
4) On-site landfills are exempted from regulatory requirements (7 states).

Construction and Demolition Residues

There are wide discrepancies in the estimates of construction and demolition residue quantities produced annually. In 1998, the EPA estimated that 136 million tons of construction and demolition residues were produced. Of this total, 48 percent were building demolition residues. Renovation residues accounted for 44 percent and new construction residues constituted eight percent. Fifty-seven percent of construction and demolition residues are produced from nonresidential sources and 43 percent are from residential sources (Table 1.3), (EPA, 1998).

Table 1.3. Summary of Estimated Building Related C&D Debris Production (1996.)

	Residential		**Nonresidential**		**Totals**	
Source	**Tons[1]**	**Percent**	**Tons[1]**	**Percent**	**Tons[1]**	**Percent**
Construction	6,560	11.3	4,270	5.5	10,830	8.0
Renovation	31,900	54.8	28,000	36.2	59,900	44.2
Demolition	19,700	33.9	45,100	58.3	64,800	47.8
Totals	58,160	100.0	77,370	100.0	135,530	100.0
Overall Percentage	42.9		57.1		100.0	

1. Million tons.
Source: EPA (1998).

There are also differing definitions of what constitutes construction and demolition debris and what constitutes recycling among states. Most construction and demolition debris definitions include both building related residues and road and bridge debris.

The Construction Materials Recycling Association (1998) estimated 200 million tons of construction and demolition (C&D) residues are produced annually. Brickner (1997) and Rathje (1992) estimated that the volume of residues directed to construction and demolition landfills exceeds 100 and 60 million tons annually, respectively. The EPA (1998) estimated that construction and demolition, municipal solid waste, and other landfills receive 65 to 85 percent of all construction and demolition residues. Open burning of construction and demolition residues (at construction sites) is practiced in many rural areas, as well as in many smaller and medium sized cities. The amount of material burned is unknown (EPA, 1998).

In 1996, an estimated 35 to 45 percent of C&D residues produced were directed to construction and demolition landfills, 20 to 30 percent were recovered for recycling, and 30 to 40 percent were disposed of in municipal solid waste landfills or other disposal sites (e.g., landfills not having permits or combustion facilities), (Turley, 1998).

In 1994, researchers at North Carolina State University (Deal & Jahn, 1995) found that approximately 27 percent of the residues reaching North Carolina landfills were construction and demolition residues. In addition, several states have commissioned studies to quantify the availability; species, wood residue types, and category of landfill residues were directed.

Construction and Demolition Landfills

The EPA (1998) reports that there are nearly 1,800 active construction and demolition landfills in the United States. Florida had the largest number (280); followed by six other states (Louisiana, North Carolina, Ohio, Kentucky, Mississippi, and South Dakota) with over 100 C&D landfills apiece. A recent survey of 850 randomly selected construction and demolition landfills in the United States (40 percent response rate) found that on average, construction and demolition landfills received 29,300 tons of residues in 1995 (Bush *et al.*, 1996). The EPA (1998) projects that 55.6 million tons of construction and demolition residues per year are disposed in permitted construction and demolition landfills.

A large percentage of construction and demolition residues produced in the United States end up in construction and demolition landfills. Since much of this waste stream is inert, solid residue rules in the majority of states do not require landfill operators to provide the same level of environmental protection (e.g., liners and leachate collection) as landfills licensed to receive municipal solid wastes. As a result, construction and demolition landfills generally have lower tipping fees, and therefore handle a large percentage of the construction and demolition debris (EPA, 1998).

The quantity of construction and demolition residues disposed of in municipal solid waste landfills is not known. It may be significant because in many areas, particularly where landfill-tipping fees are low, disposal in municipal solid waste landfills is the most common management method for construction and demolition residue. Non-permit landfills for inert materials have little or no control or record keeping by state or local governments. Some of these are on-site facilities used only for the disposal of construction and demolition residue generated at a specific site and may be closed following completion of the activity. Little data exists on the number of non-permit construction and demolition landfills nationwide (EPA, 1998).

The lowest construction and demolition landfill tipping fees are typically located in the low population density states, such as in the Midwest, where average fees have been reported at $19.70 per ton, compared to $46 and $42.60 per ton in the Northeast and West, respectively. In the South, the average is $27.10 per ton (Bush *et al*., 1996).

Estimated Recovery of Construction and Demolition Residues

The EPA (1998) classifies construction and demolition residues as having six major constituents. The materials most frequently recovered and recycled are concrete, asphalt, metals, and wood. To a much lesser degree, gypsum wallboard, and asphalt shingles have been processed and recycled.

The EPA reports that there has not been a concerted effort to track and quantify the production or recovery rate(s) of construction and demolition residues on a national basis. As a result, only general estimates can be made based on data from those local communities and states that monitor wood residue streams. Recovery rates in five selected states range from 37 to 77 percent. The five states and their reported recovery rates are as follows: Massachusetts (77 percent), Florida (46 percent), Vermont (37 percent), Oregon (42 percent), and South Carolina (40 percent). Average recovery rates were 48 percent. Using tipping fees as a guide, a conservative estimate would be that the average recovery rate might be nearly half of the average of those five states, or 20 to 30 percent of production (EPA, 1998).

The EPA (1998) suggests that the above data confirms that there is significant recovery of construction and demolition debris for recycling in these locations. However, it is not likely that these five states are representative of the United States as a whole. They expect that states keeping records may have recovery rates higher than the national average.

Construction and Demolition Residue Management Practices

An estimated 35 to 45 percent of construction and demolition residues produced are managed in construction and demolition landfills, 20 to 30 percent are recovered for recycling, and 30 to 40 percent (Table 1.4) are disposed of in municipal solid waste landfills (MSW) and other disposal sites (e.g., non-permit landfills or combustion facilities), (EPA, 1998).

Table 1.4. Estimated Quantities of Building-Related C&D Residues (1996.)

Management Option	Million tons per Year	Percent
Recovered for recycling	25-40	20-30
C&D landfills	46-60	35-45
MSW landfills or other[1]	40-55	30-40
Total	110-136	100

1. Includes non-permit landfills or combustion facilities.

Source: Franklin Associates (1994).

The EPA (1998) estimated the largest segment of demolition residue is the nonresidential segment (33 percent) and residential demolition (15 percent). Residential and nonresidential renovation debris constitutes 23 and 21 percent, respectively. New construction represents approximately eight percent of the total construction and demolition debris, with residential (3.4 percent) and nonresidential (4.8 percent). The estimate of 136 million tons per year is equal to 2.8 pounds per capita per day. This compares to 4.3 per capita per day of municipal solid residue production.

Deconstruction

Deconstruction is a new term to describe the process of selective dismantling or removal of materials from buildings before or instead of demolition. A developing trend in the United States is to remove materials of value from buildings prior to and before demolition for recycling or reuse (National Association of Homebuilders Research Center (NAHB), 1996). Results from a residential construction and demolition study for the City of Seattle indicated that 51.1 percent of the residues produced were wood residues.

Wooden materials may include lumber, flooring, doors, stair units and stringers, window frames and sills, and sheathing (EPA, 1998).

The EPA (1998) reports that demolition contractors have been practicing deconstruction in varying degrees for several years in order to remove the more valuable materials prior to demolition by conventional methods. This activity, along with recovery of demolition materials after the building has been taken down, has increased significantly since the 1970's and 1980's (Taylor, 1997). Deconstruction minimizes contamination of demolition debris, thus increasing the potential for marketing recovered materials. It is labor intensive by nature and typically requires more time than traditional demolition (EPA, 1998).

Traditionally the demolition of old buildings has been regarded as a low technology process. Contractors focus mainly on a fast demolition rate and rapid site clearance. Special measures for material separation were not possible or available due to time constraints or other site related factors (e.g., space limitations), (Poon, 1997).

To ensure that all demolition residues are acceptable for recycling, it will be necessary to alter the traditional methods and introduce selective deconstruction. This method will require that before and during the deconstruction process, a concise sorting of materials will have to be executed. Selective demolition is principally a reversal of the construction process and may follow the following procedures:

1. Removal of remains and fixtures;
2. Stripping, internal clearing, removal of doors, windows, roof components, insulation, water, air conditioning, electrical wiring, and equipment, which leaves only the building shell;
3. Deconstruction of the building shell;
4. Demolition of remaining structure (Lauritzen & Hahn, 1992).

McQueen and Stevens (1998) investigated the removal of CCA treated lumber residential decks by surveying carpenters in the Southern United States. Respondents were queried on several aspects of residential deck removal in the Southeast; specifically the age of the deck at removal, reason for removal, disposal method, and disposal costs. Survey results indicated the major reasons for deck replacement were wood aesthetics, rotten or insect infested wood, new style of deck desired, or that the deck was structurally unsound. Additionally, they reported that the mean deck age at removal was nine years and that decks were removed primarily as a result of rotten or insect infested wood (57 percent). The majority of decks taken out of service were landfilled at an average cost of $50 per deck.

While not principally concerned with the removal of CCA treated lumber structures, several deconstruction demonstration projects have been completed recently and results indicate that high diversion rates may be achieved (EPA, 1998). These projects give us the opportunity to compare associated costs and recovery rates for used CCA treated lumber structures to discrete segments of the following projects. The NAHB Research Center completed the deconstruction of an apartment building in Maryland. They measured the volume and weight of all materials on site, whether materials were salvaged, recycled, or landfilled. The diversion rate was 76 percent by weight and 70 percent by volume (NAHB, 1997).

Riverdale Case Study

The Riverdale case study was conducted on a 2,000 square foot, four unit residential building in Baltimore County, Maryland. The study was a joint effort between the National Association of Homebuilders and the EPA. Researchers documented the time required to manually deconstruct, salvage, recycle, and dispose of 25 different building materials (Table 1.5). It was estimated that 55 percent of deconstruction time was spent processing materials, 37 percent on actual deconstruction, and eight percent of the time was for production support (NAHB, 1997).

Barriers to Deconstruction and Recycling

The concept of recycling is increasing in popularity, but there are many social, legislative, and economic barriers to the use of recycling as a primary residue management method (Powelson & Powelson, 1992). Sabatier and Mazmanian (1980) segmented those barriers into three categories:

1. *Scope and Manageability*: The problem of solid residues involves long-term behavioral changes in a large target audience and it is difficult to address and cannot be solved through simple behavior modification. Behavioral variation (e.g., individuals who do not want to comply with regulation) within the target population can pose difficulties in the program implementation process;

2. *Structure of the Implementation Process*: Through the selection of implementing agencies and officials, provisions for funding, and other influences, legislators can favorably affect the implementation process. Under staffed and under funded agencies have little chance of carrying out such programs successfully;

3. *Non-statutory Variables*: Political support for government programs is critical to its success, provisions for funding such as recycling are required (which seeks to change the behavior of a large number of people). State and local agencies are pressured to develop a regulatory environment due to socioeconomic conditions and the importance of the original problem. Mass media has been a well-established factor influencing both public and government policy and can significantly increase the likelihood of a discrete program's successful implementation.

Table 1.5. Labor Summary of Tasks Performed for Deconstruction (man-hours.)

Component	Disassembly	Processing	Product Support[A]	Component Total	Labor-Hours per Unit
Doors, frames, and trim	5.75	5.25	0.00	11.00	0.55 per item
Baseboards	4.75	5.00	0.00	0.00	0.19 per lf[B]
Kitchen cabinets	2.75	0.50	0.00	3.25	0.27 per item
Oak strip flooring	19.25	27.00	0.25	46.50	0.04 per ft^2
Interior partition walls	6.25	24.75	3.00	34.00	0.18 per lf
Windows and trim	10.00	2.50	0.50	13.00	0.54 per item
Ceiling joists	1.00	4.75	0.50	6.25	0.08 per lf
Interior load bearing walls	2.75	5.50	1.75	23.25	0.07 per ft^2
Second level sub-floor	16.00	6.00	1.25	23.25	0.02 per lf
Second level joists	7.25	6.25	1.50	25.00	0.03 per lf
First level sub-floor	7.75	8.00	0.00	15.75	0.02 per ft^2
First level joists	7.70	0.00	0.00	17.00	0.02 per ft^2
Stairs	2.50	0.75	0.75	4.00	0.30 per riser
Roof sheathing boards	21.25	14.50	1.50	37.25	0.21 per lf
Roof framing	7.25	9.75	7.00	24.00	0.02 per lf
Total	122.20	274.25	18.00	83.50	

A. Supervision and technical support.
B. Lineal foot.
Source: NAHB (1997).

Sabatier and Mazmanian (1980) further state that new programs require intelligent and aggressive personnel to implement plans. They must be persistent in developing new standards and regulations. And they must be willing to enforce standards in spite of resistance from both politicians and the public.

Perhaps one the most frequently referenced analysis techniques regarding barriers is the work of Porter. Porter (1980) asserts that there are six barriers to entry and typically these barriers are adjoined with existing competitor reaction towards the threat of new entrants into a market, which may make it difficult for new entrants to succeed. Porter’s entry barriers are economies of scale, product differentiation, capital requirements, switching costs, channels of distribution, government policy, and cost disadvantages independent of product scale.

Of these aforementioned barriers, economies of scale (as it relates to availability of recycled lumber), product differentiation (the ability to differentiate recycled lumber from “new” or “virgin” lumber), distribution channels, and government policy appear to be most applicable to the recycling of and utilization of CCA treated lumber.

The major barriers to increased recycling and recovery rates appear to be: the cost of collecting, sorting, and processing; the low-value of the recycled content material in comparison to the cost of new materials; and the low-cost of construction and demolition residue landfill disposal. Also included in the barriers are time availability, salvaged lumber does not have grade stamps, quality and quantity of materials available, and labor (both costs and availability). Responses to a survey of North American aggregate producers indicated that plant permitting issues, as well as product specifications that favor the use of virgin materials, were also problems facing recyclers (Block, 1998).

The NAHB (1997) and California Integrated Waste Management Board (CIWMB) (1999) developed a list of barriers and they are as follows:

Defining the Rate of Recovery

When proposing a job with the intent to reuse or recycle a high percentage of materials produced, a minimum rate of recovery should be specified and terms such as "recover" must be well defined. If terms are not defined in the contract, the grinding of wood waste can be defined as recycling and meet goals stated in the contract without meeting the intent of the project. Define terms such as recycle and reuse to ensure that intended goals are met and that there is a level playing field for contractors bidding the project (CIWMB, 1999).

Permits

Many (but not all) local building jurisdictions require demolition permits or formal notification of intent to deconstruct or demolish a building. Approval of the demolition permit will often be linked to disconnection of electrical power, capping of all gas and sewer lines, and abatement of hazardous materials with lead and asbestos levels that were discussed previously. In general, there is not a difference between the procedures required to obtain a permit for demolition or deconstruction (NAHB, 1997).

Lumber Grading

The NAHB (1997) reports that framing lumber salvaged from older buildings may have either a lumber grade stamp that is no longer accepted by local building inspectors or it lacks a grade stamp. Grade stamps on salvaged lumber may be invalidated by alterations to the lumber (e.g., drilled holes, notches, checking, through-nail penetrations) or simply age. It is unclear when, if at all, lumber grade stamps expire.

Many lumber graders have been reluctant to regrade salvaged lumber because they feel they lack the background information and a methodology to follow regarding the structural performance of lumber that has been under load for an extended period of time. The U.S. Forest Service-Forest Products Laboratory is currently performing structural tests on the salvaged lumber in an effort to provide guidance on this issue (NAHB, 1997).

Project Time Constraints

Deconstruction in almost all cases requires significantly more time than demolition. Building deconstruction in many cases is executed under very tight time constraints (NAHB, 1997).

Worker Experience

A crew's ability to salvage material without destroying it in a timely fashion can enable a project to achieve a high recovery rate and in turn, maintain its cost effectiveness. If a project is being proposed that involves hand deconstruction and salvaging, it is imperative that professionals with salvaging experience be sought out. Experienced demolition operators are not always the best choice for salvage operations. If a project is to achieve a high rate of recovery, the operators chosen must have knowledge and/or experience in the non-destructive recovery of building materials, not just demolition experience (CIWMB, 1999).

Current Deconstruction Activities and Centers

In Seattle a business has carved out a niche market for housing deconstruction. The owner stated that each aspect of a house has a component that can be recovered. The company began deconstructing houses in 1994 and has opened a facility for selling salvaged lumber and other housing components. Wood products that are not salvageable are processed into to other products. The owner further stated that salvaged material is more common, more available, and that a major obstacle on the horizon was over saturating the lumber market (Touart, 1998).

A West Palm Beach, Florida business recycles materials from building demolition and deconstruction projects. The company has eight warehouses located on three acres for the storage and resale of materials. In addition, they deconstruct houses and primarily recover paneling, cabinets, and fixtures (BioCycle, 1999).

The City of San Leandro, California recently opened a building material exchange center. The center is operated by a private company and their employees salvage materials from new construction sites, remodeling jobs, and demolition sites. They separate materials on-site and bring them back to the center for resale. Recovered materials are sold at the site and they buy materials from other sources. In the future the company hopes to enter the deconstruction business (BioCycle, 1998).

A report in E Magazine (1997) states that recycled wood is sought after and is now being utilized in high-end homes. They report that today's homeowners can contract with builders who specialize in recycled wood. One builder stated that recycled wood is a better product because it does not shrink or swell as green wood often does. However, because recycling wood is in its infancy, recycled wood costs are more than new lumber purchased from retailers.

Recently the Austin Green Building Program of Austin, Texas was recognized as having one of twelve exemplary local government-housing initiatives on a global basis. The United Nations *Local Government Honours Programme* presented the Austin Green Building Program the award at the 1992 Earth Summit. Austin was the only city in North America to receive this distinction (Center for Maximum Potential Building Systems, 1999).

The Austin Green Building Program publishes a source book for interested parties. Their purpose is to foster the implementation of environmentally responsible homebuilding practices. The source book discusses topics that cover all aspects of housing construction, ranging from dimensional lumber to cabinetry. The source book includes definitions; individual topic discussion, commercial status of the topic, implementation guidelines, and local companies who are involved with each aspect of the topic (Center for Maximum Potential Building Systems, 1999).

The State of California operates an extensive recycling program. The Construction and Demolition Recycling Program offers several fact sheets, a case study, recyclers list, a large staff, and market development plans. The program was designed to assist in the reduction of California's construction and demolition residues to 50 percent of 1990's quantities by the year 2000 (CIWMB, 1999).

The United States Department of Energy recently began the "Center of Excellence for Sustainable Development." The focus is on all aspects of fabrication; particularly constructing green buildings (U.S. Department of Energy, 1999).

Recycling Facilities

In recent years, wood processing facilities have opened in many areas of the United States, particularly in areas with high landfill costs. Many of these facilities accept wood from construction and demolition jobs as well as other wood residues (Brickner, 1997).

Materials recovery facilities are industrial operations that process solid residues to recover commodity-grade materials for sale, or mixed-material fractions for subsequent processing for biological treatment or conversion to refuse-derived fuel. As more material types are recycled, source-separated mixtures begin to resemble mixed solid waste in composition. The main differences between mixed solid residues and source-separated materials are the number of components, their size distribution, and the type and degree of unwanted components (Berenyi, 1997).

Processing source-separated recyclables typically allows diversion of 20 to 30 percent of solid residues from a landfill. Supplementing this with source-separated commercial residue processing and recycling can increase diversion an additional 5 to 10 percent, allowing total diversions in the range of 25 to 40 percent. The total diversion can be increased still further (between 55 to 75 percent) by processing mixed residue for recovery of a compostable fraction and other types of residues (Berenyi, 1997).

The number of recycling facilities for construction and demolition residues has grown rapidly in the last few years. In 1996, it was estimated there were at least 1,800 operating construction and demolition residues recycling facilities. That number includes more than 1,000 asphalt and concrete crushing facilities, 500 wood residue-processing plants, and 300 mixed-waste construction and demolition facilities. The estimate of 1,800 construction and demolition residue facilities does not include rock crushing plants, brush and tree grinding plants, or pallet grinding operations. The largest numbers of construction and demolition residue recycling facilities were in the Western States (28 percent) and the Mid-Atlantic States (27 percent). Next are the Southeastern states (12 percent), Upper Midwestern states (13 percent), and New England states (14 percent). The Southwestern and Rocky Mountain States have only three percent of the total, respectively (Brickner, 1997).

The American Forest and Paper Association identified 315 wood processing facilities in the United States that process construction and demolition debris. Leading states for wood processing plants are North Carolina (44), Oregon (35), and California (34). The quantities of wood processed are not given in the American Forest & Paper Association report (EPA, 1998).

Leiter (1997) reports tremendous effort is being exerted to develop markets for recovered materials, thusly the number of construction and demolition recycling facilities are continuing to grow. He further reports that a July 1997 status update lists 37 new recycling plants or equipment additions in the United States (including planned projects for the remainder of 1997). Brickner (1997) estimates there are now more than 3,500 construction and demolition residues recycling facilities operating in the United States.

Products and Markets

Keller (1999) states that few areas in the solid residue industry are as frustrating and unpredictable as recycling. Certain costs are predictable (e.g., collection), but other factors, such as prices received for recyclables are not predictable and they tend to fluctuate. Prices fluctuate depending on the economy and the health of key sectors such as housing and retail sales.

Wood residues produced at construction sites generally have a better potential for reuse than wood from demolition sites due to the ease of separating the materials. Demolition wood is often less desirable because of contamination and because of the difficulty in separating the wood from other building materials (EPA, 1998).

Drywall is being recycled in several locations by first separating the paper backing, which is recycled into new paper backing, and then remixing the gypsum and using it in the manufacture of new drywall. Recovered drywall has also been used as animal bedding, cat litter, and as a soil amendment (EPA, 1998).

Wood residues have been shown to be amenable to upgrading by steam explosion. Steam explosion involves the application of high-pressure steam to organic materials, which include wood residues, for brief periods of time (one to five minutes), in a pressurized autoclave. The resulting wood residues are homogenized by steam explosion into a fibrous form useful for a range of products. These products can be used for soil amendments, microbial or enzymatic conversion to products such as ethanol, and “fractionation” into individual polymer constituents. These constituents can be cellulose, lignin, chitin, or xylan, which can be used in the production of melt-processible esters, biodegradable polymers, adhesives, fillers, pigments, and hydrogel sorbants for water purification systems and protein separations (Glasser, 1995).

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CHAPTER TWO. The Theory of Planned Behavior

Literature Review, Construct, and Model Development

This chapter provides a literature review of attitude and will define the attitude construct. Next, the conceptual model will be presented. Finally, previous research regarding environmental attitudes will be introduced and recycling as a marketing concept will also be introduced.

The Attitude Construct

Traditionally attitude was viewed as a stable disposition to respond in a consistently favorable or unfavorable manner toward a psychological object (Fishbein & Ajzen, 1999). Attitude as a hypothetical construct generally was defined as a learned predisposition to respond to an object or class of objects in a consistently favorable or unfavorable way (Kothandapari, 1971). Campbell (1963) viewed attitudes to be remnants of past experience that pilot a person's future behavior. Currently many researchers view evaluation as the primary component of attitudinal responses and that attitude is widely considered to be one's degree of favorableness or unfavorableness (i.e., evaluation) with respect to a psychological object (Fishbein & Ajzen, 1999).

However, there may be another factor influencing attitudinal response and it is affect. In the past researchers used the term affect to symbolize an attitude's evaluation of an object. This has resulted in the terms affect and evaluation being used interchangeably and others have applied affect towards mood, emotion, or arousal. With this stated, "Most researchers currently assess attitudes in terms of overall evaluations and even when affect is utilized to describe attitudinal response, affect is considered evaluative rather than emotional in nature" (cf. Fishbein & Ajzen, 1999). They also have proposed that affect be reserved as a discrete response system that is characterized by some degree of arousal and includes generalized mood states without a well-defined reference object (e.g., sadness verses happiness). This operationalism also includes differing emotions that can be qualitatively measured (e.g., anger, fear, pride).

Attitude, as proposed by Fishbein and Ajzen (1999), refers to the “Evaluation of an object, concept, or behavior along a dimension of favor or disfavor, good or bad, and like or dislike.” Attitude response examples include “Approval or disapproval, liking or disliking, and judgments of any concept.” These judgments include “Dimensions such as enjoyable – unenjoyable, desirable – undesirable, good – bad, or pleasant – unpleasant.” They also state “Evaluation differs from affect, although affect may influence an overall evaluation.”

The Expectancy – Value Model of Attitude

The premise of the expectancy – value model is that one’s overall attitude (evaluation) toward an object is ascertained by subjective values of the attributes associated with an object and by the strength of these associations (i.e., an individual belief associates the object with a certain attribute). The relationship between cognitions or beliefs and the overall attitude is employed in the expectancy – value model. In Fishbein’s (1967) theory of attitude, one's evaluation of an object was determined by “accessible beliefs about an object” and belief is defined as “the subjective probability that the object has a certain attribute.”

“The evaluation of each attribute contributes to one’s attitude in direct proportion to a person's subjective probability that the object possesses the attribute in question” (Fishbein & Ajzen, 1975). Here belief strength is defined as the subjective probability of a connection between the attitude object and an attribute and the greater the subjective probability, the stronger the belief.

On-line attitude formation entails that “attitudes toward an object are formed automatically” as one acquires new information regarding object attributes, and as the “subjective value of the attribute becomes linked with the object” (Fishbein, 1967). Individuals may form many different beliefs about an object, “but it is assumed that only a relatively small number influence attitude at any given moment.” Accessible beliefs are considered to be the principal determinants of one's attitude and “the subjective probability associated with a given belief (i.e., strength) correlates with the frequency with which the belief is emitted spontaneously (i.e., with its accessibility)” (Fishbein, 1963). Additionally, in research conducted by Kaplan & Fishbein (1969), “the order of belief emission was found to be highly accessible beliefs that tend to correlate more strongly with independent measures of attitude than do the less accessible beliefs” (cf. Fishbein & Ajzen, 1999).

Attitude construction in real-time is defined as “new issues arising that require an evaluative response and one can extract beliefs or relevant information stored in one’s memory.” And because each belief carries “… evaluative implications, attitudes are automatically formed” (Fishbein & Ajzen, 1975).

Attitude change is defined as “any change in the set of accessible beliefs or in the evaluations associated with them. Attitudes are based on the beliefs regarding the physical or psychophysical object (that are presently accessible) and are developed in the course of acquiring information about the attitude object, and evolve as existing beliefs change and new beliefs are formed.” This type of attitude change is expected “when new information about a familiar attitude object becomes available (e.g., as when a person accepts arguments in a persuasive communication). Real-time information retrieval can also produce attitude change and may polarize evaluative responses to an object" (cf. Fishbein & Ajzen, 1999).

Fishbein & Ajzen (1999) state "people are not assumed to form attitudes in a rational manner by conducting an unbiased review of all relevant information and integrating it according to formal rules of logic." However, "once a set of beliefs are formed and are accessible in memory, it provides the cognitive foundation from which attitudes are assumed to follow automatically in a reasonable and consistent fashion." And "the more strongly a belief is held (or the more positive or negative), the expected contribution to the overall attitude is greater."

In the expectancy-value model, the "cognitive foundation of an attitude can be understood by researching a person's accessible or salient beliefs about an attitude object." An accessible belief "is most likely to vary greatly from one object or behavior to another, from one situation to another, and from one population to another." This model makes "no prior assumptions that beliefs that will be accessible" (Fishbein & Ajzen, 1999).

Current Attitude Constructs

Current attitude research includes studies based on the "Systematic analysis of information and research on attitudes that are produced with minimal conscious deliberation. The information processing continuum includes dual-mode processing and assumes that the central processing of information requires ability, effort, and the motivation to devote one's cognitive resources to the task" (Fishbein & Ajzen, 1999).

“Attitudes are relatively stable response dispositions,” according to the classical view, and “Is challenged by demonstrations of mood effects on evaluations. Diffuse affective states (e.g., moods) were not the only factor found that can influence evaluations or judgments without one’s conscious awareness.” Other factors include “issue framing, linguistic context, and processing goals can bias evaluations positively or negatively.” With these contextual factors “apparently able to facilitate attitude shift in a favorable or unfavorable direction, it appears that assumed attitude stability is undermined.” In mood and evaluative priming research, “automatic attitude activation was evidenced by response times for single evaluative judgments or by inducing participants to review their past behavior in a biased manner was also found to influence attitudes.” Additionally, “linguistic context was demonstrated to influence attitudes” (cf. Fishbein & Ajzen, 1999).

By using “a single or a few direct questions to assess evaluation raises the issue of validity issues (i.e., what exactly is being evaluated).” Traditional methods of attitude scaling defined the attitude domain by utilizing a wide range of questionnaire items. As a contrast, “When respondents were asked to directly evaluate an object, it is not clear which attribute or attributes of the object he/she was considering (the focus on different attributes may produce different evaluations)” (Fishbein & Ajzen, 1999).

Fishbein & Ajzen (1999) report that “evaluative attitudes are derived from accessible beliefs about an attitude object and the quantity of deliberation that goes into attitude formation or change can vary considerably, from shallow to extensive consideration of a few items of information, and includes systematic incorporation of all the available evidence.”

The Attitude – Behavior Relationship

The attitude – behavior relationship is defined "as a disposition to respond with some degree of favorableness or unfavorableness toward a psychological object, that is, attitudes are expected to predict and explain human behavior." For example, "positive attitudes should predispose approach tendencies, as compared to negative attitudes that should predispose one to avoidance tendencies" (Fishbein & Ajzen, 1999).

Fishbein (1967) found that attitudes could be measured not only with respect to general objects but also with respect to discrete behaviors. Researchers interested in "predicting and explaining the performance of specific behaviors (in a given context) can assess behavior-specific attitudes." For example, in a study designed to gain an understanding of paper recycling, instead of measuring broad attitudes (e.g., attitudes toward protection of the environment) delay, researchers assessed attitudes toward the discrete act of recycling paper. Attitudes toward a behavior reportedly were found "to predict actual behavior very well and to a greater extent than prediction of attitudes toward the target at which the behavior is directed" (Ajzen & Fishbein, 1970; Kothandapani, 1971).

"Behavioral aggregation and behavior-specific attitudes to predict corresponding behaviors both comprise the principle of compatibility" (Ajzen, 1991). According to the principle of compatibility, "attitudes can only predict behavior to the extent that two ideas refer to the same underlying evaluative disposition. As they reflect a general evaluation of the attitude object, behavioral aggregates are compatible with attitudes toward the target of the behaviors. This can be contrasted to a specific action performed in a particular context and is only compatible with the evaluation of the specific behavior in question" (Fishbein & Ajzen, 1999).

The Planned Behavior Construct

Fishbein and Ajzen (1999) state “That in the behavioral belief construct a favorable or unfavorable attitude toward a behavior is produced; the construct of normative belief or the subjective norm is perceived as social pressure; and the control belief construct gives rise to perceived behavioral control (i.e., factors that motivate or hinder the performance of a behavior).” Behavioral beliefs involve beliefs regarding the consequences of performing a behavior and “subjective norms and perceived behavioral control are assumed to emerge spontaneously and automatically (similar to attitudes) as people form normative and control beliefs, respectively.”

Combining attitude toward the behavior and behavioral control “leads to the formation of a behavioral intention. The more positive or favorable an attitude and subjective norm and the greater the perceived control, the stronger should be an actor’s intention to perform a behavior (as a general rule). With a sufficient degree of *actual* control over a behavior, an actor is expected to execute his/her intentions when the opportunity arises.” Therefore, “intention is assumed to be the immediate antecedent of behavior, and guide behavior in a controlled and purposeful manner.” Nevertheless, “several types of behaviors present execution difficulties (and these may limit self-control), a researcher should consider perceived behavioral control in addition to intention.” To the extent that an actor is realistic in their judgment of a particular behavior’s difficulty, “a measure of perceived behavioral control can function as a substitute for actual control and contribute to the prediction of the behavior in question” (Fishbein & Ajzen, 1999).

The theories of reasoned action and planned behavior “assume that human behavior is reasoned, controlled, or planned in the sense that it takes into account a particular behavior's likely consequences, normative expectations of important referents, and other factors that may hamper performance." Actual beliefs held may sometimes be unfounded or biased; therefore "one's attitudes, subjective norms, and perceptions of behavioral control are believed to follow spontaneously and reasonably from these beliefs. This produces a corresponding behavioral intention and ultimately results in a behavior that is consistent with the overall theme of the beliefs." They also note that this "does not necessarily imply a deliberate and effortful retrieval of information, or construction of attitudes prior to every behavior." In addition, "Attitudes, subjective norms, and perceived behavioral control are assumed to be available automatically as the performance of a behavior is being considered" (Fishbein & Ajzen, 1999).

Fishbein & Ajzen (1999) report that most researchers agree that the automatic attitude – behavior sequence must meet all or most of the following criteria:

- Automatic attitudes are unintentional (i.e., an act of will is not required to initiate them);
- Automatic attitudes occur beyond one's awareness;
- Automatic attitudes are uncontrollable (i.e., one cannot stop the attitude-behavior sequence once it has started);
- Automatic attitudes without effort, in that automatic attitudes do not interact or 'hinder conscious or unconscious cognitive processes.'

The theory of reasoned action "suggests that attitudes, as well as behaviors are guided by accessible beliefs (accessible attitudes that are expressed in the context in which the behavior is performed)." In addition, "This occurs not only because they are automatically activated but also strong attitudes are reported to be grounded in accessible beliefs and are relatively stable over time. Attitude predictive validity should decline when accessible beliefs (in the attitudinal context) differ from the accessible beliefs in the behavioral context." And it was reported "that attitudes should predict behavior best when the salient dimensions (profound at the time of attitude assessment) are those that are naturally salient at the time of the behavior" (Fishbein & Ajzen, 1999).

Habit or past behavior (as a reasoned action) is based "on the recognition that a strong relationship between a prior and later behavior only proves the temporal stability of the behavior in question." Habit, therefore, "is only one of several possible mediating factors and may not be needed to account for behavioral stability. Under certain conditions the prior behavior frequency will be a powerful predictor of later behavior." Measurement of prior behavior "reflects the operation of all factors, both internal and external, and controlled performance (or nonperformance) of a past behavior." The theory of planned behavior attributes behavioral stability over time to the stability of the intention and perceived behavioral control. Both of these factors are presumed to determine past behavior, and, if the factors remain unchanged, they "will produce a corresponding behavior in the future. Habit is not assumed to control behavior" (Fishbein & Ajzen, 1999).

The Theory

The theory of planned behavior (Ajzen, 1991) is the theoretical model for this research and evolved from the theory of reasoned action (Fishbein & Ajzen, 1980). The model will allow the investigation of attitudes and attitude determinants that influence a contractor's intention and ultimately the behavior to recover, reuse, or recycle spent CCA lumber.

A central factor in the theory is concerned with an individual's intention to perform a given behavior. It is assumed that "intentions capture the motivational factors that influence a behavior." These are "indicators that reflect the intensity to try (i.e., how hard) and the degree of effort one plans to exert in order to perform a behavior" (Ajzen, 1991). The conceptual model illustrates the effects of contractors' attitudes regarding their intention to recycle and ultimately the performance of the behavior (Figure 2.1).

The proposed model conveys the relationship between behavioral, normative, and control beliefs and their affect on intention and ultimately the recycling behavior. These effects are reportedly mediated by three constructs, namely, attitude toward a behavior, subjective norms, and perceived behavioral control. The theory of planned behavior, at a basal level, "postulates that a behavior is a function of salient information (beliefs) that is relevant to that particular behavior. Salient beliefs are considered to be the predominant determinants of one's intentions and actions" (Ajzen, 1991).

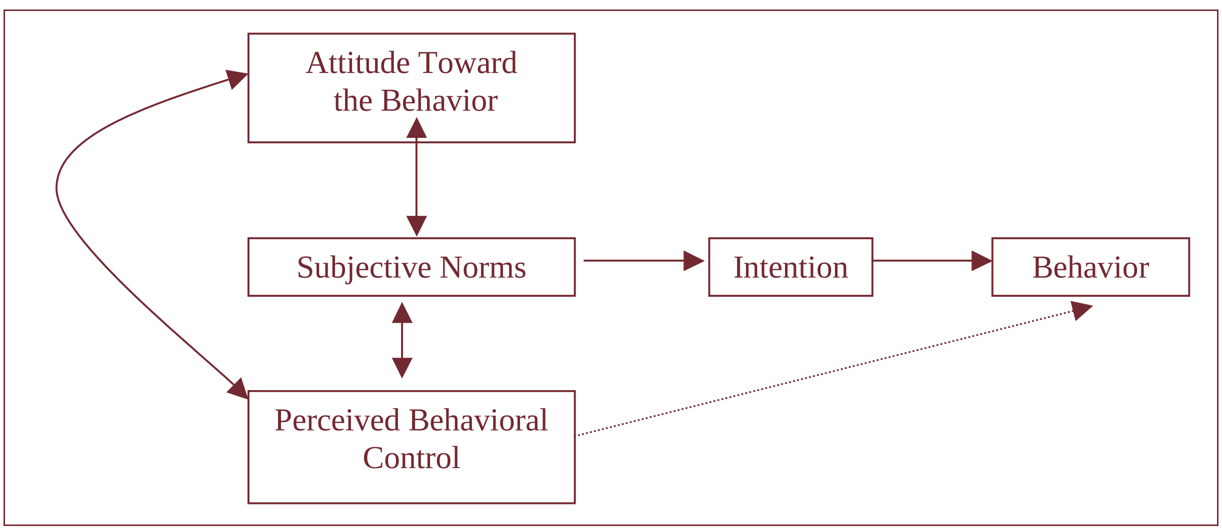

Figure 2.1. The Theory of Planned Behavior.
Source: Ajzen (1991).

Additionally, the theory hypothesizes that three constructs guide human action and they are presented below:

- "Beliefs regarding the likely consequences (positive or negative) of the behavior (behavioral beliefs – attitude toward a behavior),"
- "Beliefs regarding the normative expectations of others (normative or subjective beliefs),"
- "Beliefs regarding the presence of factors that may further or hinder the performance of the behavior (behavioral beliefs or perceived behavioral control)" (Fishbein & Ajzen, 1999).

Ajzen (1991) states that "An interaction between intention (motivation) and perceptions of behavioral control can occur and this action is a component of predicting behavior."

Attitude Toward the Behavior

Attitudes reportedly develop "from beliefs one holds regarding the attitude object and refers to the degree to which one has a favorable or unfavorable evaluation or appraisal of the questioned behavior." Generally it is believed that "a person forms a belief about the object of the attitude by associating or linking the object with discrete attributes." In regards to attitudes toward a behavior, "Each belief links the behavior to a certain outcome, or to another attribute (e.g., cost incurred by performance of the behavior). These attributes are linked either positively or negatively, and one automatically and simultaneously acquires an attitude toward a behavior. One learns to favor a behavior that they believe has desirable consequences and disfavor behaviors tending toward undesirable consequences. Subjective value consequences contribute to attitude in direct proportion to the strength of the belief or the subjective probability that the behavior will produce the questioned outcome" (Ajzen, 1991).

Ajzen (1991) reports methodological issues must be considered and they pertain to the scaling of belief and evaluation items. Belief strength is typically assessed by means of a seven point graphic scale (e.g., likely – unlikely) and evaluation by a seven point evaluative scale (e.g., good – bad). He further states that "belief strength measures should probably be unipolar (e.g., 1 to 7, 0 to 6) and evaluation scales should be bipolar (e.g., -3 to +3), as evaluations are assumed to form in a bipolar continuum." The behavior strength equation is presented below:

$$A \propto \sum_{i=1}^{n} b_i e_i$$

A ~ one's attitude;
b ~ strength of each salient belief;
e ~ subjective evaluation of the belief attribute;
n ~ salient beliefs.

"The strength of each salient belief (*b*) is combined (in a multiplicative manner) with the subjective evaluation (*e*) of the belief's attribute. The resultant products are summed over *n* salient beliefs. One's attitude (*A*) is directly proportional ($\propto$) to the summative belief index." With this methodology, one can attain an attitude estimate, and this estimate "represents a respondents evaluation of the object or behavior under consideration" (Ajzen, 1991).

Subjective Norms and Normative Beliefs

Normative beliefs are defined as "one's concern with the likelihood that important referent individuals or groups approve or disapprove of the performance of a given behavior." Or it refers "to the perceived social pressure to perform or not perform a behavior. Normative belief strength (*n*) is multiplied by one's motivation to comply (*m*) with the referent in question. The subjective norm (*SN*) attained is directly proportional (∝) to the sum of the resultant products across *n* salient beliefs" (Ajzen, 1991), and the equation is presented below:

$$SN \propto \sum_{i=1}^{n} n_i m_i$$

SN ~ subjective norm;
n ~ strength of each normative belief;
m ~ one's motivation to comply;
n ~ salient beliefs.

Ajzen (1991) reports, "a global measure of the subjective norm is typically obtained by asking respondents to rate the extent to which are important others in one's life would approve or disapprove of their performing a given behavior." Global measures of subjective and belief-based measures are usually obtained by utilizing bipolar scales for normative beliefs and unipolar scoring of the motivation to comply.

Perceived Behavioral Control

Actual behavioral control is defined as "one's having the available resources and opportunities to achieve a behavior." Perceived behavioral control is defined as "one's perception of the ease or difficulty of performing the behavior of interest" and perceived behavioral control "is of greater interest than actual control." In the theory of planned behavior, "one may believe that outcomes are determined by their individual behavior (internal locus of control) and also believe that their chances of attaining a goal or completing a behavior is minimal (low perceived behavioral control). Both internal locus of control and goal attainment are concurrent thought processes" (Fishbein & Ajzen, 1999).

A belief set (control beliefs) that involves the "presence or absence of the required resources and opportunities ultimately determine intention and action to perform a behavior. Control beliefs may be based on past experience, or influenced by second hand information, by the experiences of friends or acquaintances, or by other factors." The greater the "number of resources and opportunities one believes they have, in conjunction with anticipated reduced obstacles or impediments, the greater the perceived control over the behavior should be" (Ajzen, 1991).

"Each control belief (*c*) is multiplied by perceived power (*p*) of the particular control factor that facilitates or impedes the performance of the behavior. The resultant products are then summed across *n* salient control beliefs, which produce the perception of behavioral control" (Ajzen, 1991). The perceived behavioral control equation is presented below:

$$PBC \propto \sum_{i=1}^{n} c_i p_i$$

PBC ~ perceived behavioral control;
c ~ control belief;
p ~ perceived power;
n ~ salient control beliefs.

"Beliefs regarding available resources and opportunities are viewed as the basis of perceived behavioral control." And these beliefs can affect the decision-maker on whether to recycle or not to recycle (i.e., action). Bipolar scaling is recommended for measuring both control beliefs and the perceived power of the control factor (Ajzen, 1991).

In regards to recycling and the theory of planned behavior, one could assume that recycling beliefs would be a tangible decision regarding the favorable or unfavorable outcomes (consequences) of recycling. A recycler may tend to concentrate on the manner (means) or outcomes (e.g., time, effort, convenient or inconvenient, money).

Attitudes and Recycling

Minimal benefit is typically received from recycling used or spent products. And "recycling often involves considerable personal costs (e.g., time, money, effort)," (Smith, Haughtvedt, & Petty, 1994). Conversely, important societal benefits can be obtained by recycling, if not for the present, then for future generations. Many researchers view "Recycling as an act of altruism" (e.g., Hopper & Neilsen, 1991; Vinning & Ebreo, 1992; Bagozzi & Dabholkar, 1994; DeYoung, 1988/1989; Lee & Holden, 1999).

Attitude research has been conducted to predict energy conservation behavior, environmental concern, and recycling (Balderjahn, 1998). More succinctly, researchers have found that attitudes toward the environment did correlate with behavior, but the findings were richer when attitude was measured toward a specific action. Lee and Holden (1999) found that "recycling behavior was driven by a cost-benefit analysis, where the behavior in question having the greatest net benefit is the favored behavior." Respondents in another study indicated that "the greater the perceived influence on a behavior, the greater likelihood that they would perform the behavior" (Ellen *et al*., 1991). Hopper and Neilsen (1991) state, "Behavior is influenced by social and personal norms and the awareness of the consequences of enacting a recycling behavior." Utilizing the Theory of Planned Behavior, Shaw and Clarke (1999) reported "that the factors surrounding beliefs do play a significant role in actual behavior." In addition, "Information acquisition led respondents to perceive that they were empowered to recycle and thusly influence the environment in a positive way." Vining and Ebreo (1992) found that "non-recyclers were more concerned with financial incentives or rewards for recycling and with personal convenience." Additionally, they state "recyclers were more aware and knowledgeable of recycling than non-recyclers."

Samdahl and Robertson (1989) report "researchers exploring underlying belief structures are most important for investigating environmental related subjects." In addition, "researchers must be very specific as to the constructs they are studying." One can conclude that attitude measurement, in terms of specificity (Ajzen, 1980) appears to affect attitude measurement.

Marketing and Recycling

Recycling can be viewed as an opportunity for marketers. In 1971, Kotler and Zaltman defined social marketing as "the design, implementation, and control of programs developed to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research."

Shum *et al*. (1994) envisioned recycling behavior as the product, recycling cost(s) as the price, and promotion (communication) as different strategies to reach different groups. Finally, distribution (place) may be thought of as the means to accomplish a given behavior.

When one views "recycling as managing the marketing mix, it has implications for recycling research. Nearly all recycling research can be viewed as paralleling marketing research or rather all of the research presumably has the goal of selling the recycling concept" (Shum *et al.*, 1994).

As the literature review of attitude has demonstrated, attitudes and attitude formation, intentions, and performing the ultimate behavior are intertwined and highly complex. Considerable attitude research has been conducted and several studies regarding recycling also have been conducted; however (to this investigators knowledge) no research has been conducted on an actual professional group. Gaining an understanding of builder and deconstructor attitudes will go towards developing programs to initiate recycling programs or supplement existing programs.

The theory of planned behavior is a widely used method to explore attitudes and allows the researcher to introduce variables that will allow for the discernment of builder and deconstructor attitudes. These are the two primary reasons this model was selected for this research.

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CHAPTER THREE. A Profile Of CCA Treated Lumber Removed From Service In The United States Decking Market

INTRODUCTION

Recent research regarding the quantities of preservative treated lumber taken out of service indicates that there is a pressing need to determine the factors affecting the recovery, recycling, and the subsequent utilization of used CCA treated lumber. However, the major caveat is a fundamental lack of knowledge regarding those pertinent factors associated with the removal, recovery, and recycling of CCA treated lumber.

Recovery, as it pertains to this research, concerns diverting spent CCA lumber from landfills. It can include the dismantling of a deck for future research, the pulling of nails from the old deck boards and stringers, or remanufacture of some type.

This research project focused on the removal of CCA treated Southern yellow pine products utilized in decking applications. Southern yellow pine is the primary species group that is preservatively treated in the United States. Production is estimated to average nearly six billion board feet a year during the time frame 1997 to 2004 (Southern Forest Products Association (SFPA), 2000). The SFPA also estimates that over two billion board feet were utilized in the fabrication of decking in 2000. Treated Southern yellow pine is also used in many other applications, which includes framing, trusses, wood foundations, agriculture, industrial uses (e.g., marine, highway, and material handling), fences, landscaping, remodeling, and products for export. It should be noted that the largest share of treated lumber is estimated to be utilized in outdoor decking, nearly 38 percent (SFPA, 2000).

Several investigators in the past decade have estimated the volume of CCA treated lumber being removed from service. The estimates of CCA treated lumber taken out of service range from nine million cubic meters in the year 2000 (Cooper, 1993) to nineteen million cubic meters in 2020 (Felton and DeGroot, 1996). The largest share of treated lumber taken out of service is believed to be derived from the demolition of and remodeling of outdoor decks. McQueen and Stevens (1998) projected that nearly twelve million cubic meters of treated lumber will be removed from service in 2004.

Additionally, there is growing concern over both the disposal of spent CCA treated lumber and treated lumber *in situ* applications. Recent and ongoing work in the State of Florida has revolved around the leaching of treatment chemicals into the soil and alternative methods of disposal for used CCA treated lumber. An alternative to the disposal of used lumber directed to landfills is the recovery of and subsequent recycling of spent lumber. However, a plethora of factors are not understood or known about the potential recovery of spent CCA treated lumber. These factors include decks sizes, the number of deck removals, the quantities of CCA treated lumber removed, age of the treated lumber at removal, current fabrication and remodeling practices, deck removal factors, lumber disposal practices, and barriers toward the recovery and recycling of used lumber. These factors must be investigated in order to affect the recovery and recycling of CCA treated lumber.

Estimating the quantities of treated lumber taken out of service is critical, as we need to develop accurate estimates or validate previous estimates. First, state, county, and city officials need reliable estimates to develop recovery programs and the centers to accommodate the used CCA lumber being taken out of service. Second, industry and university researchers will have the opportunity to recommend different applications and potential markets. Finally, current information is required for governmental officials and university researchers to direct future research in this area.

Objectives

1. Generate a profile of the decking construction industry that includes estimates of current decking fabrication, demolition, replacement practices and components, and disposal.

2. Estimate the quantities of CCA lumber being removed from service in the sample states and estimate decking lumber being removed from service nationally.

3. Identify the factors that affect the recovery of spent CCA treated lumber.

METHODOLOGY

Population

Contractors associated with the fabrication, demolition, and deconstruction of residential decks were the population of interest for this study. The contractors sampled for this research were from Georgia, North Carolina, and South Carolina.

Sample Frame

The sample frame was obtained from the American Business Disc 2000 (InfoUSA, 2000), which listed a total of 5,902 contractors (with the capability to construct decks) in GA, NC, and SC (Harmonized System Codes (HS) 15 and 17). The sample was randomly selected deck and patio builders, deck builders, and also included homebuilders, carpenters, handymen, fence contractors, and general contractors located in the sample states. Response rates for studies of these particular professions have been low, ranging from 6 to 14 percent (e.g., Eastin *et al*. 1999; Kozak & Cohen, 1999; McQueen & Stevens, 1998).

Potential respondents were selected by utilizing a simple random sampling method and the sample was developed according to the minimum number of required subjects to ensure the appropriate use of a structural equation modeling program. Hair *et* *al*. (1999) suggest that the minimum number of subjects received (to conduct proper analysis) was 100.

Assuming a minimum of 100 subjects, a seven percent response rate, and twelve percent of the surveys being undeliverable, a minimum of 2,262 questionnaires were needed. To facilitate a proper sample being achieved, every third member of the sample frame was also included in the sample (224 contractors). Additionally, 347 patio and deck builders (deck building was listed as their primary occupation) were also sampled, resulting in the total number of questionnaires mailed to 2,833 randomly selected members from the population.

Data Collection Process

The primary data collection tool was a self-elicitation mail survey questionnaire. The mail survey and sequencing were modeled after Dillman's (1978) Total Design Method. A prenotification letter (Appendix A) was mailed on July 25, 2000, two weeks before the questionnaires were mailed. The purposes of the letter were to explain the nature of the research and to request and encourage them to participate in the research. In addition, a financial reward (a $200 gift certificate from the Home Depot™) was offered to the participants in order to increase the response rate. Two weeks after the pre-notification letter was mailed, the questionnaire (Appendix B) packet was mailed on August 5, 2000. This included a cover letter and the questionnaire form.

Two weeks after the initial questionnaire package was mailed, a reminder postcard (Appendix C) was mailed to the non-respondents. The reminder postcard encouraged non-respondents to participate in the research and thanked the respondents for replying to the survey. A re-mailing of the entire package to the non-respondents occurred four weeks after the initial mailing. Again, a reminder postcard was mailed to non-respondents two weeks later. In mid-October, a cover letter pleading for non-respondent participation and questionnaire were mailed again to the non-respondents. After a two-week period, a reminder post card was mailed to the non-respondents. In total, the randomly selected contractors were sent seven mailings (if they did not respond to the survey).

The questionnaire was designed to gather data regarding deck fabrication, demolition, deconstruction, disposal, and recovery factors regarding used CCA treated lumber. Questions (included in the questionnaire) queried respondents on several facets of construction and recovery, and included the number of decks built and demolished, the age of treated lumber at deck removal, deck replacement practices, and factors for removal or construction of new decks.

Prior to final questionnaire development, contractors were contacted through personal visits in the Commonwealth of Virginia and the State of Maryland and by phone to solicit their thoughts regarding the recovery of used CCA lumber. Critical issues regarding the recovery of treated lumber were identified. After this process, specific questions within the questionnaire were designed to meet research objectives. In addition, scholars from Virginia Tech and personnel from the U.S. Forest Service Southern Research Station also assisted in the questionnaire development.

The questionnaire was pre-tested during the spring of 2000 via a mail and facsimile survey. Respondents were asked to identify questions that may be troublesome to answer and for their input regarding question wording. Eighteen contractors from the

Commonwealth of Virginia responded to the pretest. After the pretest and minor modifications, the questionnaire was finalized for printing.

Data Analysis

The returned questionnaires where examined for completeness and usability. Questionnaires deemed acceptable were coded and entered into the SPSS® statistical analysis spreadsheet.

The first phase entailed executing descriptive statistical techniques to check for incorrectly entered items. Secondly, a check for skewness, kurtosis, and normality was conducted. Next, frequency distributions and arithmetic means were produced for deck fabrication and deconstruction analysis, factors regarding deck replacement, disposal, and factors concerning recovery.

To gain an understanding of the differences or similarities among the builders of decks, the respondents were segmented into two separate groups. Group one (full-time deck builders) was comprised of respondents whose primary occupation was listed as deck building (Harmonized System Code). The second group (part-time deck builders) was comprised of contractors and others whose primary occupation was not listed as deck building, but they did build decks. Full-time deck builders contained 115 subjects and the part-time deck builder group was comprised of 284 subjects.

Results and Discussion

The questionnaires were mailed to 2,833 contractors in the selected states. From these, 681 were returned as undeliverable or refused. Undeliverable questionnaires included contractors that had gone out of business, contractors that moved without a forwarding address, or certain contractors that had an expired forwarding address. Three respondents refused the final mail survey questionnaire packet. Ten companies requested by phone or by letter to be removed from the study. This resulted in a total of 2,139 contractors as potential respondents.

In total, 580 questionnaires were returned. The first question asked the respondent if their company fabricated decks. One hundred and eighty respondents answered *No*, and *Yes* was checked by 400 respondents. Figure 3.1 illustrates the distribution of the respondents by United States postal zip codes.

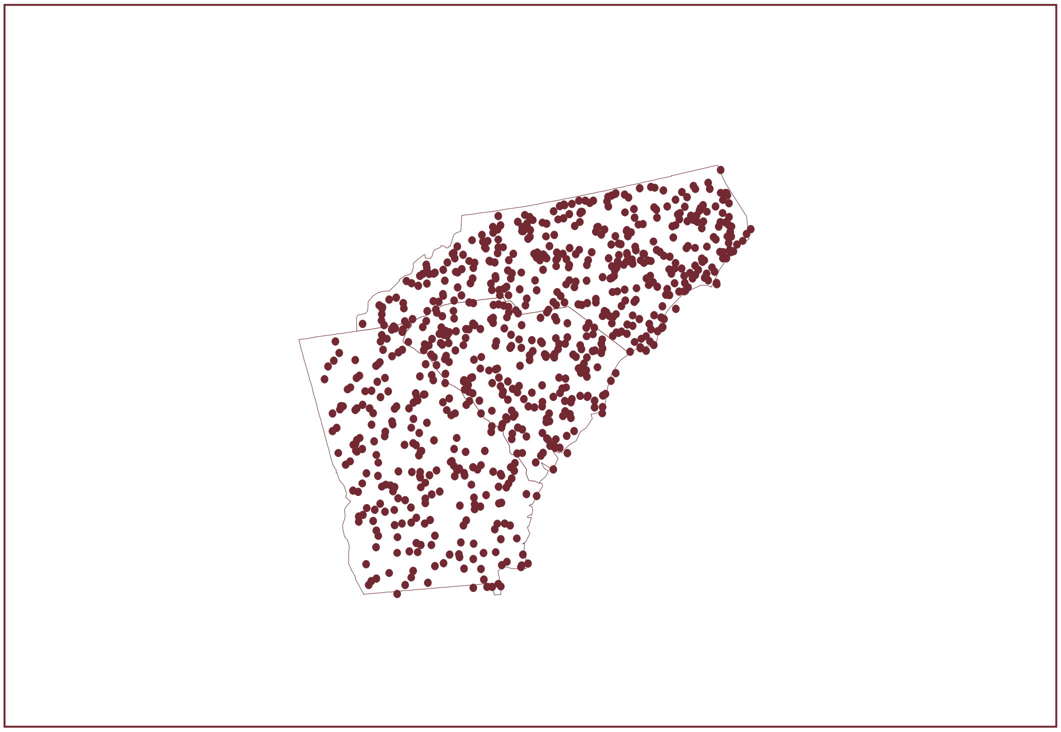

Figure 3.1. Distribution of the Respondents by United States Postal Zip Code.

The total adjusted response rate was calculated by subtracting the bad addresses from the mailing total and dividing it into the usable responses. The total adjusted response rate was 27.1 percent.

Non-Response Bias

To ensure the validity of the research, non-response bias procedures were employed. Contractors that did not respond to the mail survey questionnaire were randomly selected and contacted by phone. These individuals were asked five pre-selected questions from the questionnaire. A total of 30 responses were collected for the non-response bias investigation.

An independent samples student t-test was executed to discern if there were statistical differences between respondents and non-respondents on the pre-selected questions. There were no significant differences detected on four of the questions. The question that resulted in a significant difference asked respondents, “In your opinion, what percentage of decks are repaired or built by the homeowner?” (Table 3.1). This statistical finding may be due to the wording of the question, as the question should have been two separate and distinct questions.

Table 3.1. Telephone Survey, Respondents versus Non-Respondents, Non-Response Bias.

Category	Respondent Mean	Non-Respondent Mean	p-value
Decks built in 1999	12.6	16.5	0.37
Deck size-square feet	165.7	198.6	0.19
Age at removal - years	11.3	12.8	0.10
Built by owner - percent	6.7	35.3	< 0.00
Discards (scraps) - percent	7.5	7.2	0.76

Additionally, the Armstrong-Overton (1977) wave analysis method was employed and contrasted the first 30 respondents against the last 30 respondents. No statistical differences were discovered utilizing this method ($\alpha = 0.05$), (Table 3.2).

Table 3.2. Armstrong-Overton Method, Non-Response Bias Results, Early versus Late Respondents.

Category	Respondent Mean	Non-Respondent Mean	p-value
Decks built in 1999	11.2	14.4	0.53
Deck size-square feet	198.0	203.3	0.89
Age at removal - years	13.5	12.8	0.52
Built by owner - percent	35.8	33.2	0.61
Discards (scraps) - percent	5.8	7.0	0.28

Demographic Profiles

In order to develop profiles of decking practices and CCA lumber removals, several questions were designed to collect this information. This information is segmented into eight categories that include: deck fabrication and demolition, deck remodeling and components, associated costs and recoverable wood, factors for deck replacement, disposal methods, and recovery factors. In addition, responses to the qualitative questions will be presented. The following sections expound on the findings beginning with deck fabrication and demolition, which is followed by the estimation of CCA treated Southern yellow pine lumber removals.

Deck Fabrication and Demolition

To develop the quantities of CCA treated lumber being taken out of service, it was necessitated that several questions regarding deck fabrication and demolition be put forth. Data were collected on the number of decks built in 1999, the average size (square feet) of decks built in 1999, decks demolished in 1999, the average size of decks demolished in 1999, the average age of the decks removed in 1999, the percentage of decks built or remodeled by the homeowner, and discards (i.e., scraps) from deck fabrication.

The mean number of decks built per respondent in 1999 was 31.2 and the average size of the decks was approximately 272 square feet. In a recent article by Shook and Eastin (2001), they reported an average deck size of 239 square feet for spec homes and 398 square feet for custom homes in the Southeastern United States. In addition to the survey data collected, deck building permits were also analyzed in this study. This involved collecting deck sizes from permits issued in Charlotte, NC, Greenville SC, and Decatur, GA. An independent samples t-test was executed to discern if differences existed between respondent data and deck permit data. There was not a significant difference found between respondent and deck permit data regarding the size of decks built in 1999, with a p-value > 0.40 ($\alpha = 0.05$).

The average number of decks demolished in 1999 was 7.6 per respondent and the decks averaged about 198 square feet per deck. The increase in the mean size of a deck should be encouraging news to the producers of Southern yellow pine.

The average age of decks at removal was nearly 13 years (Table 3.3). This was four years higher than reported by a previous study. McQueen and Stevens (1998) estimated that the average age of a deck at removal was nine years. Truini (1996) reported that decks are repaired, remodeled, or expanded after 10 to 12 years.

Analysis of respondent data indicates that over 35 percent of decks were either built or remodeled by the homeowner. This finding is in line with Truini (1996), who reported that do-it your-self builders fabricate 40 percent of all decks. Also, the Home Improvement Research Institute reported that homeowners build 46 percent of all decks (cf. Shook & Eastin, 2001). Finally, over seven percent of the lumber purchased to construct a deck resulted in discards or scraps (Table 3.3).

Table 3.3. Deck Fabrication and Removal Demographics.

Category	n	Mean
Decks built in 1999	392	31.2
Square feet – built in 1999	389	271.6
Decks removed in 1999	299	7.6
Square feet – removed in 1999	278	198.6
Age of decks at removal	283	12.8
Decks built/remodeled by owner - percent	371	35.3
CCA lumber discards - percent	384	7.1

A very significant difference was found between full-time and part-time deck builders regarding the number of decks demolished in 1999, with a p-value < 0.01 (α = 0.05), (Table 3.4). This may indicate that full-time deck contractors are more involved with the demolition of older decks as compared to part-time deck contractors. No statistical differences were found among the other questions.

Table 3.4. Contrasts of Full-time vs. Part-Time Deck Builders - Deck Fabrication and Removal Demographics.

Category	Full-Time Mean	n	Part-Time Mean	n	p-value
Decks built in 1999	45.6	114	25.3	278	0.11
Size-square feet built	292.9	114	262.9	275	0.14
Decks demolished in 1999	12.4	99	5.4	204	< 0.01
Size-square feet demolished	189.5	93	203.2	185	0.39
Age at removal	12.5	93	13.0	190	0.41
Built by owner - percent	32.6	110	36.4	261	0.10
CCA lumber discards - percent	6.5	116	7.4	268	0.08

Estimation of CCA Treated Southern Yellow Pine Lumber Removals

A primary focus of this research was to determine the quantities of CCA treated lumber being removed from or taken out of service. As mentioned previously, the disposal of spent CCA treated lumber is a topic of concern among researchers, both in the treating and Southern pine manufacturing industries, and particularly in the State of

Florida. The quantity estimates of CCA treated lumber coming out of service will allow us to gauge if removals are a pressing problem and provide information for industry and government personnel to develop recovery facilities and businesses.

The Southern yellow pine (SYP) CCA treated lumber production data used in this research was obtained from the Southern Forest Products Association (2000), the American Wood-Preservers' Association (1999), and the American Wood Preservers Institute (1995). Additionally, to obtain the treated lumber materials and quantities required to fabricate a deck, we utilized Lowe's™ Project Design System. The quantity of SYP-CCA treated lumber removed from service (in 1999) in the selected states and the lumber removed from the demolishing of decks in the United States was determined by using the average deck size, the estimated board footage contained in a deck, the average number of decks removed per respondent, the sample frame and national population estimates, and the percentage of decks built by the homeowner.

Deck Size and Treated Lumber Quantities

Drawing upon the analysis of respondent data, the average deck demolished in 1999 was approximately 198 square feet. A statistical method for indicating the reliability of an estimate is achieved by establishing confidence limits as estimate parameters. The confidence interval for the average square footage contained in a deck was 183 to 214 square feet. This parameter was calculated by using a large sample size approximation (Freese, 1967). In order to estimate the lumber required in a deck, we used the dimensions of 12 feet by 16 feet, which results in a deck that contains six square feet less than the average reported demolished deck. The treated lumber required for a 192 square foot deck was estimated to be 1,057 board feet. The estimated material requirements are strikingly similar to that found by George Carter and Affiliates in 1989 (cf. Shook & Eastin, 1996), as they estimated 1,029 board feet of treated lumber were contained in a deck built in 1987.

Extrapolation and Assumptions

The extrapolation was based on several assumptions and they are as follows:

- The estimation will be for 1999,
- The average deck size is 12' by 16' and contains 1,057 board feet,
- Eight decks per builder are demolished,
- DIY'ers demolish 35.3 percent of all treated lumber decks,
- There are 5,902 builders in the sample states and 88,579 in the U.S.

The sample frame included 5,902 members from the States of Georgia, North Carolina, and South Carolina. Nationally, the study population contained 88,597 members. To calculate the average number of decks demolished per respondent, the reported number of decks were summed and divided by the number of respondents. The average number of decks reported demolished per respondent was 7.6. In order to provide a conservative estimate, the aforementioned average was expanded to eight decks per respondent.

To obtain the total number of decks demolished in the selected states, the decks demolished per respondent were multiplied by the sample frame population. This yielded 47,216 decks demolished in those states (in 1999). This total was multiplied by 1,057 board feet (the estimated board feet contained in a deck), yielding 49,907,312 board feet (full sawn) removed in 1999 (Table 3.5). Using an alpha level of 0.05, the 95 percent confidence interval for this estimate is 38.1 million to 61.0 million board feet.

Table 3.5. Deck and SYP-CCA Lumber Removals in GA, NC, and SC.

Category	Respondent Mean	Decks Removed	Board Feet/ Deck	Board Feet Removed
GA, NC, SC	8 decks	47,216	1,057	49,907,312

The estimated board footage total was then adjusted by multiplying the percentage estimate of homeowner construction (35.3 percent) by the estimate of board removed. The estimated CCA treated lumber removal was 67,524,593 board feet in the selected states (Table 3.6). The 95 percent confidence interval for this estimate is 52.5 million to 82.5 million board feet ($\alpha = 0.05$).

Table 3.6. Estimated SYP-CCA Lumber Removal in GA, NC, and SC (including DIY[1].)

Category	Board Feet Removed	DIY percent	Total Board Feet Removed
GA, NC, SC	49,907,312	35.3%	67,524,593

1. Do-it-yourself homeowner

The national estimate of decking lumber removals was executed in the same manner. The national population contained 88,597 members (HS Codes 15 & 17). The total number of decks demolished in 1999 was 708,776 and 749,176,232 board feet of decking lumber were removed (Table 3.7). Using an alpha level of 0.05, the 95 percent confidence interval for this estimate is 582.5 million to 915.8 million board feet.

Table 3.7. Deck and Deck Lumber Removals in the United States.

Category	Respondent Mean	Decks Removed	Board Feet/ Deck	Board Feet Removed
National	8 decks	708,776	1,057	749,176,232

Adjusting for homeowner fabrication, the total board footage removed nationally was 1,013,635,442 in 1999 (full sawn), (Table 3.8). The 95 percent confidence interval for this estimate is 788.2 million to 1.2 billion board feet ($\alpha = 0.05$). Conversion of this total resulted in 84,469,620 cubic feet or 2,392,180 cubic meters of decking lumber removed in 1999.

Table 3.8. Estimated Decking Lumber Removal in the United States (including DIY[1].)

Category	Board Feet Removed	DIY percent	Total Board Feet Removed
National	749,176,232	35.3%	1,013,635,442

1. Do-it-yourself homeowner.

Deck Demolition and Remodeling Component Practices

To gain insight into current demolition and remodeling practices, respondents were asked several questions regarding the building of decks and deck component replacement. Three hundred twenty-three respondents reported building completely new decks in 1999. Of this total, 136 (42.1 percent) indicated that they fabricated new decks exclusively. Nearly 21 percent (39) reported building new decks more than 90 percent of the time (Figure 3.2).

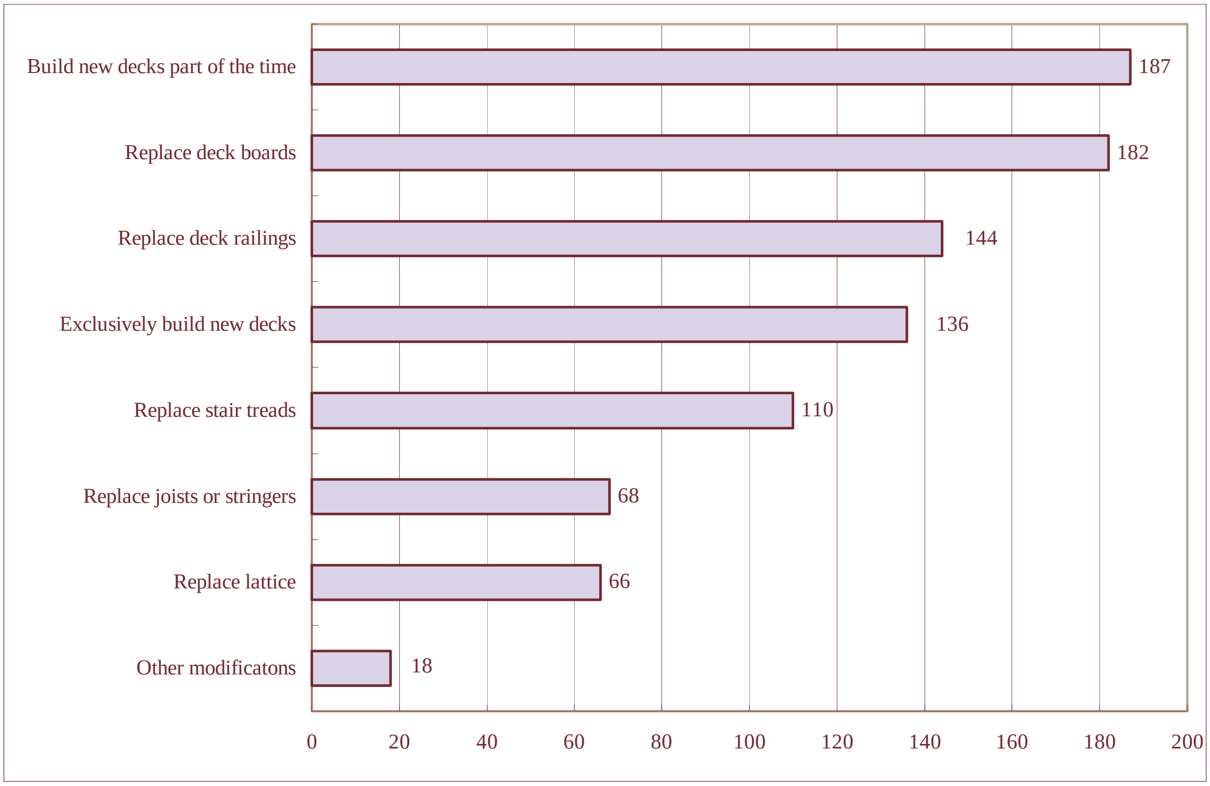

Figure 3.2. Frequency Distribution of Deck Fabrication and Remodeling Components.

Nearly 45 percent of the respondents indicated that they remodeled decks in 1999. Deck board replacement was the most common remodeling procedure, with 182 (64.6 percent) respondents indicating this. The replacement of deck railings was the next most common procedure, with 144 (45.5 percent) reporting the replacement of railings. Stair tread replacement was reported by 110 respondents, and 68 indicated that they replaced joists or stringers in decks. The replacement of deck lattice was reported by 66 respondents, and finally, 18 respondents indicated that other types of remodeling procedures were employed. This included the turning over of deck boards, replacing supports, replacing poplar posts, rebuilding a deck with concrete, and adding new hardware (Figure 3.2).

Statistical contrasts were performed for this section of questions and no significant differences were found between the groups ($\alpha = 0.05$), (Table 3.9).

Table 3.9. Contrasts of Full-Time vs. Part-Time Deck Builders - by Deck Fabrication and Remodeling Component Practices.

Category	Full-Time Mean Percent	n	Part-Time Mean Percent	n	p-value
Built new decks	81.0	104	76.0	219	0.13
Replaced deck boards	17.7	57	22.1	125	0.15
Replaced deck railings	10.1	44	15.3	100	0.17
Replaced stair treads	10.5	32	11.7	78	0.49
Replaced joists/stringers	11.1	16	9.2	50	0.34
Replaced deck lattice	8.6	19	10.6	49	0.40
Other practices	24.3	6	22.8	12	0.88

Deck Demolition and Deconstruction Costs

Respondents were asked questions concerning the costs associated with deck demolition and deconstruction. The importance of these questions lies in the fact that financial incentives could be developed to encourage the recovery of used lumber. The average disposal cost reported by the respondents was nearly $180 per deck (Table 3.10).

Table 3.10. Average Estimated Deck Demolition and Deconstruction Costs.

Category	n	Mean Cost
Disposal cost	293	$179.56
Additional cost for deconstruction	242	$370.57

The respondents were asked to estimate the additional cost for dismantling a deck for recovery rather than demolishing the deck. The average cost for deck deconstruction was more than two times the estimated cost for demolishing a deck, nearly $371 per deck (Table 3.10). Intuitively, this should indicate that financial incentives will have to be incorporated, in conjunction with other programs, promotions, and facilities for recovery to become a viable option.

Contrasts were executed for statistically significant differences, and there was no evidence to support that the two groups differed regarding costs ($\alpha = 0.05$), (Table 3.11).

Table 3.11. Contrasts of Full-Time vs. Part-Time Deck Builders - Deck Fabrication and Deconstruction Costs.

Category	Full-Time Mean Cost	n	Part-Time Mean Cost	n	p-value
Disposal cost	$189.62	92	$174.96	201	0.63
Additional cost for deconstruction	$410.65	71	$353.93	171	0.48

Potential Lumber Recovery

Participants in the study were next asked several questions regarding the percentage of lumber that could be potentially recovered from a deck, and used lumber currently being recovered from decks. This information can be utilized to recommend new applications for used lumber, and the building of the requisite recovery facilities.

Regarding the percentage of treated lumber that could be potentially recovered, it was found that over 44 percent could be potentially recovered. The mean percentage of lumber reported being recovered from dismantling a deck was over 51 percent (Table 3.12). This finding is contradictory to the results discerned in the primary disposal section, where only 64 respondents reported recovering used lumber.

Table 3.12. Estimated Lumber Recovery Potential and Quantities Recovered for Used CCA Lumber.

Category	n	Mean Percent
Potential CCA lumber recovery from deck demolition (%)	339	44.3
Quantity of CCA lumber recovered from deck demolition (%)	339	51.4

Contrasts were executed between the groups and there were no significant differences found between the groups on the aforementioned questions ($\alpha = 0.05$), (Table 3.13).

Table 3.13. Contrasts of Full-Time vs. Part-Time Deck Builders - Lumber Recovery and Quantity Recovered.

Category	**Full-Time Mean Percent**	**n**	**Part-Time Mean Percent**	**n**	**p-value**
Potential CCA lumber recovered	43.7	106	51.1	233	0.83
Quantity of CCA lumber recovered	44.5	105	51.5	234	0.92

Deck Replacement Factors

These questions were designed to gain an understanding of the factors concerning deck replacement. This information can be used by the producers of Southern yellow pine for product offerings and promotions. And it may also be used to encourage the restoration and/or expansion of a deck rather than demolishing the old deck.

The highest rated factor for deck replacement was decayed wood at 5.3. This was followed by aesthetics and was rated 5.2. Third, the physical degradation of the wood components was rated at 5.1. Safety, or a structurally unsound deck was the next highest factor rated for deck replacement, followed by homeowners preferring a larger size deck. Other reasons for deck replacement, in order of importance, where poor construction, a new deck style preferred, insect infested wood, and finally, a new material was preferred (Figure 3.3).

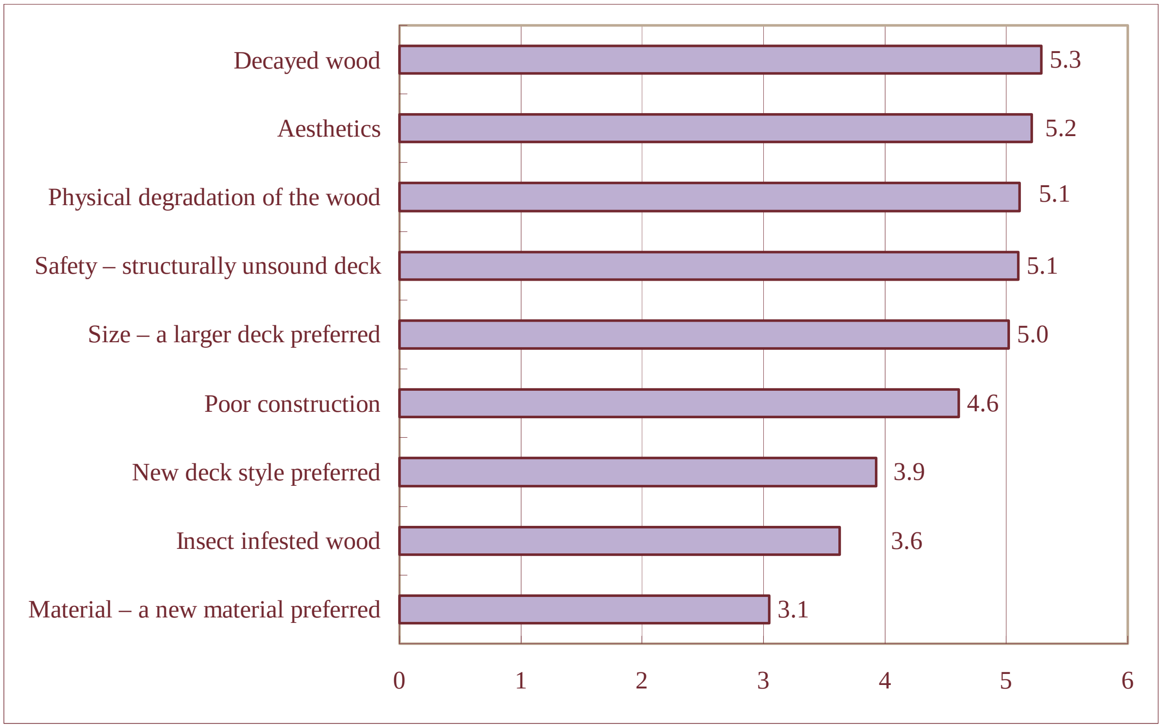

Figure 3.3. Deck Replacement Importance Factors.

Statistical contrasts were performed on these factors and there was no evidence that significant differences exist between the groups (α = 0.05), (Table 3.14).

Table 3.14. Contrasts of Full-Time vs. Part-Time Deck Builders – Deck Fabrication and Removal Demographics.

Category	Full-Time Mean Percent	n	Part-Time Mean Percent	n	p-value
Decayed wood	5.3	113	5.3	263	0.84
Aesthetics – wood appearance	5.2	115	5.2	263	0.75
Physical degradation of the wood	5.1	112	5.1	252	0.98
Safety – structurally unsound deck	5.0	114	5.1	261	0.72
Size – a larger deck preferred	4.9	114	5.1	263	0.34
Poor construction	4.4	113	4.7	263	0.23
Style – a new deck style preferred	4.0	112	3.9	260	0.61
Insect infested wood	3.6	114	3.6	255	0.81
Material – a new material preferred	2.9	114	3.1	260	0.35

Primary Disposal Facilities and Methods

Data were collected on the primary disposal methods and the facilities that contractors directed their used lumber. Figure 3.4 illustrates disposal methods and facilities. Concerning the primary method of disposal a contractor used, 289 reported they disposed of used lumber in municipal solid waste landfills (MSW). Of this total, 179 respondents used MSW facilities exclusively. Additionally, 32 directed disposals to MSW landfills more than 90 percent of the time. Construction and demolition facilities (C&D) were used by 48 respondents, and 21 respondents directed their used lumber to C&D facilities exclusively. Forty-one replied that they disposed of spent CCA lumber at private facilities either exclusively or part of the time.

Spent lumber was recovered for reuse by 64 respondents, and one respondent indicated that they recovered all of their used lumber for reuse. Again, this finding contradicts the findings from the previous section. Of this total, six reused the material more than 90 percent of the time. Contract disposal was utilized by 35 respondents, and 15 respondents used other disposal methods. Other disposal methods included using the recovered lumber to build deer stands; reused it in the home, disposed of it in a dumpster, the homeowner gave it away, contractors buried it, or they gave it away. Fifty-two respondents reported burning used lumber as their primary or alternative disposal method. Of this total, 45 burned the used material less than 50 percent of the time. The burning of treated lumber is prohibited and is detailed on the consumer information sheet that is given to buyers at the time of purchase.

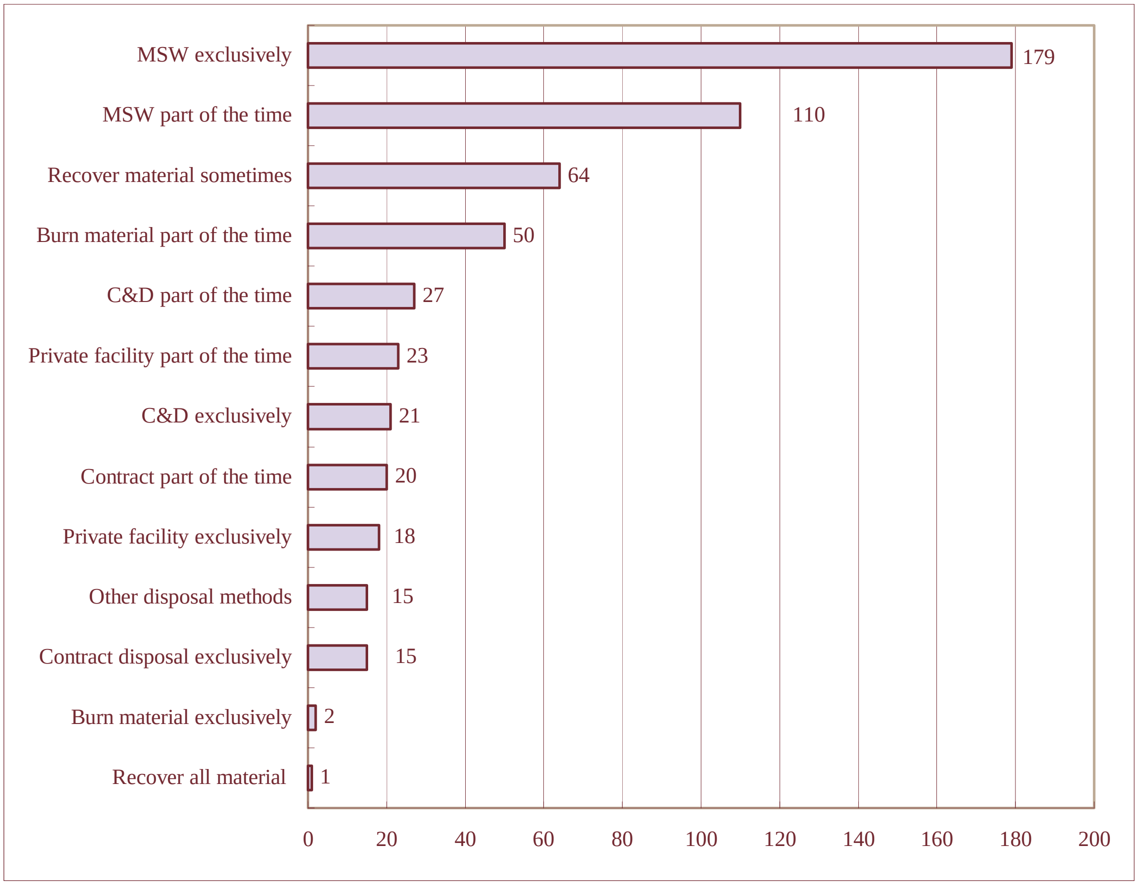

Figure 3.4. Frequency Distribution for Disposal Facilities and Methods for Used CCA Treated Lumber.

Full and part-time deck builders were contrasted regarding disposal methods and facilities and there was no evidence that these groups differed (α = 0.05), (Table 3.15).

Table 3.15. Contrasts of Full-Time vs. Part-Time Deck Builders – Deck Fabrication and Removal Demographics.

Category	**Full-Time Mean Percent**	**n**	**Part-Time Mean Percent**	**n**	**p-value**
MSW landfill	83.7	84	87.7	205	0.23
Recovered for reuse	37.5	20	32.9	45	0.61
Burned	17.8	15	26.0	37	0.20
Landfilled at a private facility	54.5	10	65.6	41	0.44
Landfilled at a C&D facility	73.4	16	66.9	32	0.54
Contract disposal	62.7	11	62.7	24	0.92
Other disposal methods	62.4	7	46.6	8	0.50

Lumber Recovery Factors

When contemplating the recovery of used CCA lumber, there are several factors that a contractor must consider. These factors include time, costs, a lack of recycling facilities, recycling programs in place to assist a contractor, the manpower to dismantle, and equipment. Respondents were asked to rate each of these factors utilizing a global rating scale (Figure 3.5).

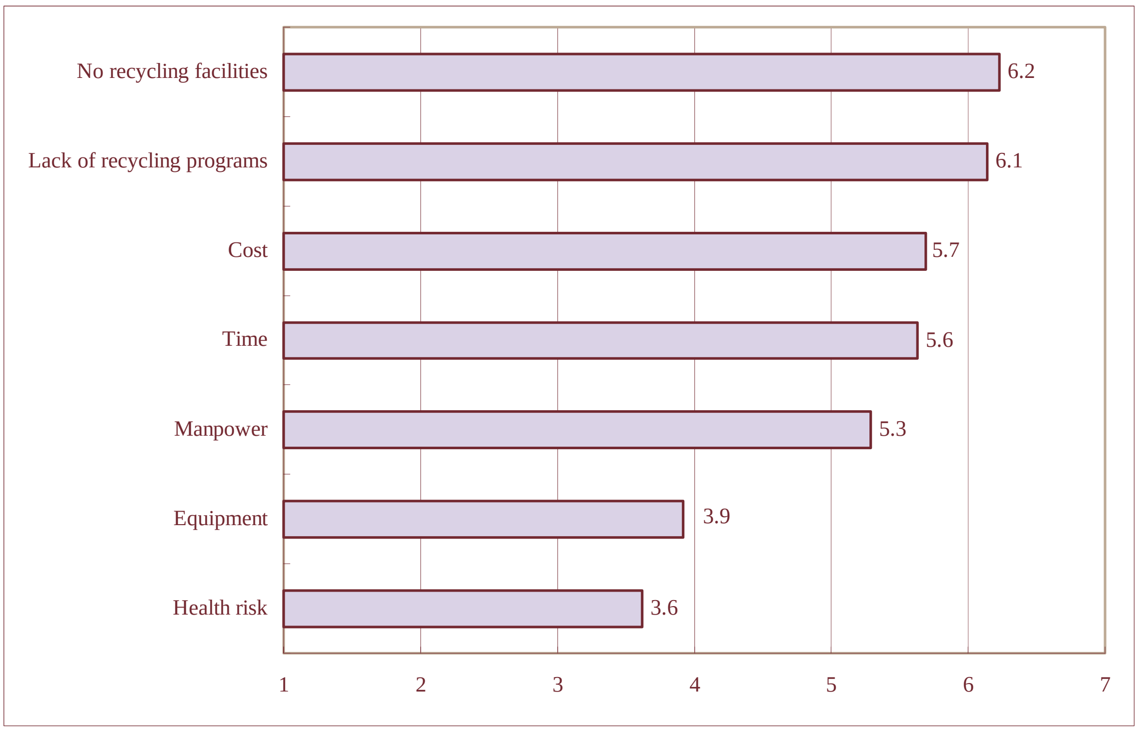

Figure 3.5. Lumber Recovery Importance Factors.

Not surprisingly, a "lack of recycling facilities" was rated the highest at 6.2. This was followed closely by a "lack of recycling programs", which had a mean rating of 6.1. The costs associated for dismantling a deck was the third highest rated factor at 5.7. The next highest rated factor was time, followed by manpower, equipment, and health risk was the lowest rated factor (Figure 3.5). Most salient are the factors "lack of recycling facilities," and "lack of recycling programs," which indicates that recovery programs and centers will have to be developed and built in order to facilitate the recovery and recycling of used CCA treated lumber.

Statistical contrasts were executed on each factor by contractor group ($\alpha = 0.05$). One significant difference was discerned, the time factor (p-value = 0.04). This may indicate that those who are full-time deck fabricators are more aware of the time involved in dismantling a deck. There was mild evidence of a statistical difference between the groups regarding a lack of programs (p-value = 0.09) and the cost associated with dismantling a deck (p-value = 0.08). Again, this gives some evidence that full-time deck builders may be more conscious of the factors involved regarding the dismantling of a deck. There was no statistical evidence to support that the two groups differed on the remaining factors (Table 3.16).

Table 3.16. Contrasts of Full-Time vs. Part-Time Deck Builders – Lumber Recovery Importance Factors.

Category	Full-Time Mean	n	Part-Time Mean	n	p-value
No recycling facilities	6.0	113	6.2	266	0.24
Lack of recycling programs	5.9	112	6.2	268	0.09
Cost	5.4	112	5.7	268	0.08
Time	5.3	114	5.7	269	0.04
Manpower	5.1	113	5.3	266	0.19
Equipment	3.7	110	3.9	261	0.32
Health risk	3.5	109	3.6	264	0.60

Qualitative Question Results

The respondents next were asked two open-ended questions. The first queried the respondents for their opinion on what incentives or programs could be instituted or developed to initiate the recovery and recycling of spent CCA treated lumber.

Respondents offered 321 ideas or opinions on possible initiatives, and 129 respondents mentioned financial incentives. Contractor responses indicated that some type of financial incentive needed to be offered to facilitate recovery (Figure 3.6). Concerning the financial incentives that could be offered, 31 percent reported that some type of financial incentive should be offered. Next, nearly 29 percent indicated that there should not be any tipping fees or a reduction in tipping fees. Fourteen percent indicated that the incentive should be based by the pound or by the ton. Next, 11.6 percent of the respondents reported that they should be paid to recover the material. Nearly eight percent indicated that some type of tax break should be instituted. Other incentives included retailer discounts (2.3 percent) and penalties or fines should be incorporated to initiate recovery (2.3 percent). Less than two percent (1.5 percent) indicated that they should receive a discounted price at the time of purchase, and less than one percent (0.3 percent) indicated that a fund should be established for demolition.

The establishment of recovery facilities was the next most frequently reported response. Nearly 70 percent of the respondents indicated that recovery centers needed to be developed and easy access to those facilities should be available to contractors. Next, over 17 percent responded that separate areas should be developed at the landfill site. Participants also reported that business establishments such as Home Depot or Lowe's should establish the recovery centers (5.4 percent). The respondents also reported that dumpsters or containers should be made available at the job site (3.2 percent), the recovery facilities should also receive spent lumber that contain nails (3.2 percent), and treated lumber manufacturers should provide recovery centers and accept used treated lumber (1.1 percent), (Figure 3.6).

The establishment of recovery programs was the next highest rated response category at 11.2 percent (Figure 3.6). The most frequently reported option was the development of a buyback program (36.1 percent). This was followed by the establishment of industry or government pickup programs at the job site (27.7 percent). Next, both the development of a county government recovery program or building associations in conjunction with a government agency recovery program were recommended equally (13.9 percent). The next three response categories each were mentioned equally (2.8 percent), and included local governments contracting with builders, the establishment of a community recycler, and that any program developed should not include any government agency participation.

Several respondents indicated that public education programs needed to be developed, nearly nine percent (Figure 3.6). Respondents reported that the public education program should include methods for demolition, material on why the recovery of spent CCA treated lumber was necessary, and literature on the potential health risks associated with the building and demolition of CCA treated structures.

The next highest rated response category involved products and processing equipment (2.5 percent), (Figure 3.6). The respondents indicated that the development of a viable product line was necessary (71.4 percent). Next, the development of processing equipment and processing techniques should be incorporated (13.3 percent each). Finally, respondents reported that a listing of alternative products to CCA treated lumber should be made available to them (2 percent).

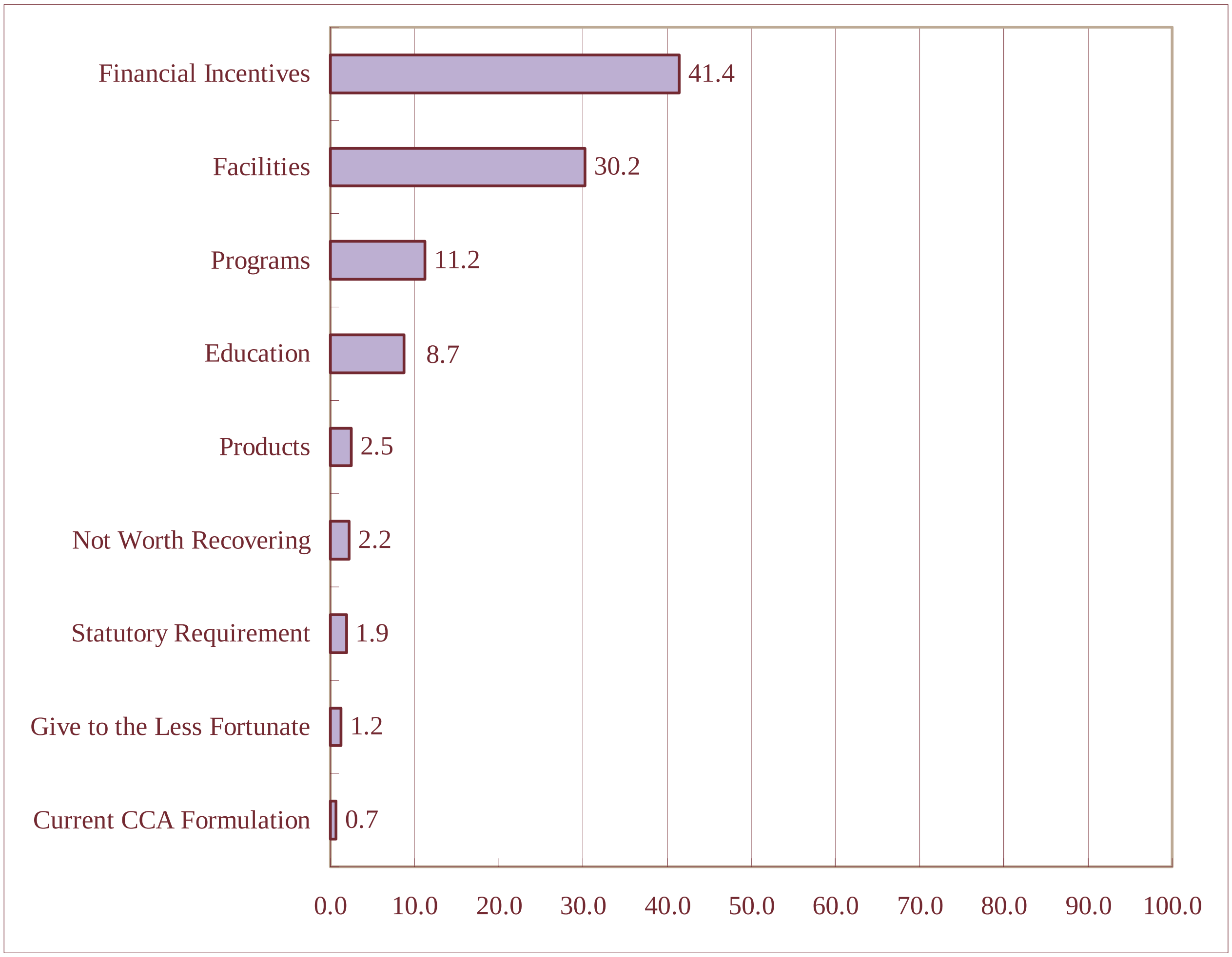

Figure 3.6. Frequency Distribution Of Suggested Recovery Incentives or Programs.

Over two percent of the respondents indicated that the used CCA treated products were not worth recovering. Next, nearly two percent of the respondents reported that statutes should be instituted to initiate the recovery of spent CCA treated products. More than one percent of the participants reported that the used CCA treated materials should be given to the less fortunate in local communities (Figure 3.6).

The final category involved the constituents of CCA treated lumber products currently being manufactured and was less than one percent of the responses (Figure 3.6).

Responses indicated that the retention level of CCA treated products should be increased or improved, or that the arsenic contained in CCA products should be removed.

Participants were next asked to offer their opinion on the types of products that could be produced from recovered CCA treated lumber (Figure 3.7). It should be noted that the following results are actual responses of the study participants and are not the opinions of the researcher. Virginia Tech, the Department of Wood Science and Forest Products at Virginia Tech, or the USDA Forest Service endorses or recommends any of the following uses, recommendations, or products for spent CCA lumber.

For this question, the largest response was utilizing the CCA treated lumber to manufacture some type of engineered wood product(s) (32.0 percent). In the engineered wood category, a variety of products were listed and included microlam, parallam, laminated veneer lumber, and medium density fiberboard (46.1 percent). Next, the production of treated oriented strand board was mentioned (42.6 percent). The manufacture of composite decking material was the next most frequently mentioned product (6.1 percent). Other potential products reported included miscellaneous composite products (2.6 percent), treated finger jointing (1.7 percent), and fillers for composite products (0.9 percent).

The use of CCA treated lumber for outdoor home applications was the next highest product category at 24 percent (Figure 3.7). The most frequently mentioned response was to apply the recovered lumber as landscape borders (31.4 percent). This was followed by the manufacture of lawn furniture (19.7 percent) and for the building of playground structures (12.7 percent). Both fencing materials and flower planters were also mentioned (8.1 percent). The manufacture of lattice (7.0 percent) and pickets (4.7

percent) followed. Other uses included the manufacture of birdhouses and feeders (3.5 percent each). Finally, tree houses, screen doors, gables and vents, or the recovered lumber could be used in the repair of porches (1.2 percent).

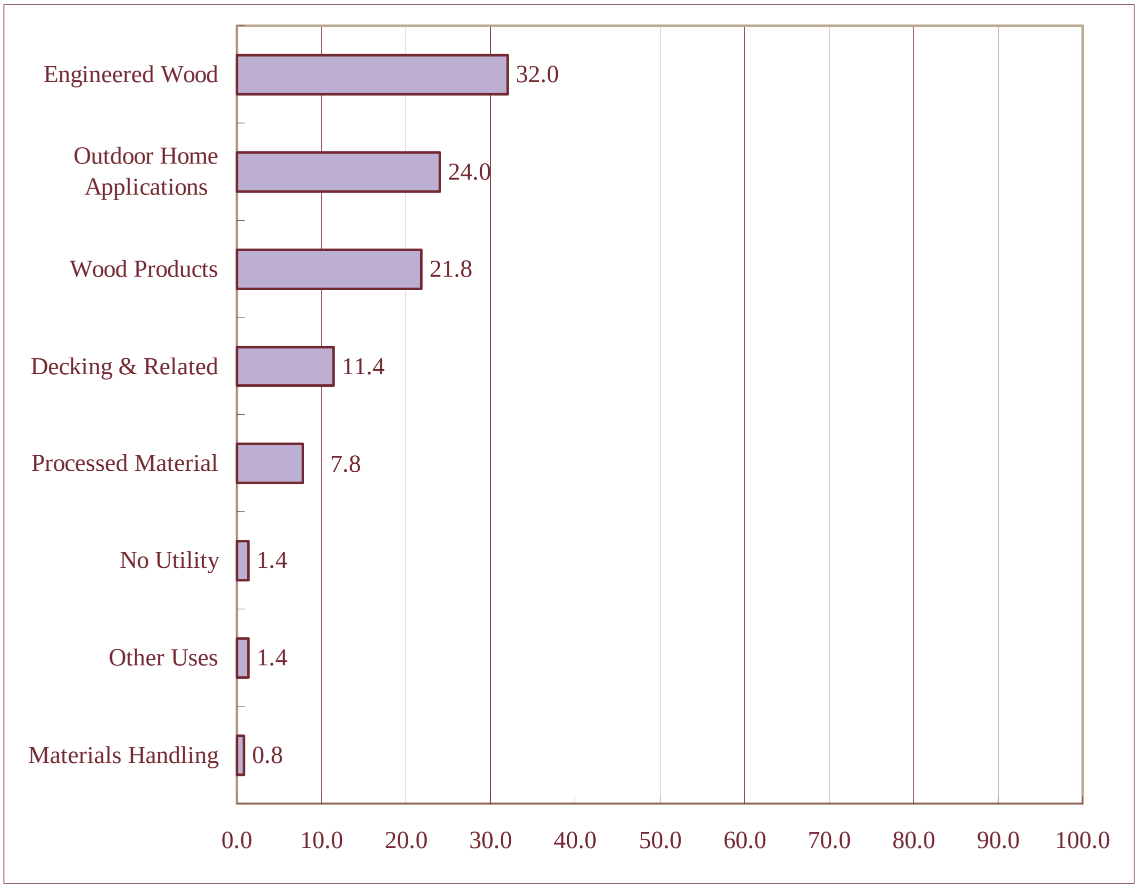

Figure 3.7. Frequency Distribution for Potential Products Manufactured from Recovered CCA Treated Lumber.

The manufacture of miscellaneous wood products from spent CCA treated lumber was the next product category (21.8 percent), (Figure 3.7). Stakes (31.9 percent) were the most frequently mentioned product. This was followed by using recovered lumber as forming materials (15.8 percent), both the manufacture of other lumber products and firewood logs were 7.9 percent, and followed by using the material for posts (6.6

percent). Non-visible support structures, reuse the larger pieces in other applications, and the manufacture of small wood products followed, each at 3.9 percent. The use of treated lumber for the construction of mudsills, baller boards, and artwork were also equal (2.6 percent). The following products were mentioned and each comprised 1.3 percent of the wood product category. These products include spindles, parking stops, signs, crawl space lumber, deer stands, mats, and use the material for sub-flooring.

The manufacture of decking and decking related materials were mentioned in 11.4 percent of the responses (Figure 3.7). In this category, the fabrication of small decks from used CCA treated lumber was the most frequently mentioned response at 61.6 percent. Next, the construction of walkways (22.6 percent) and the manufacture of stair treads (12.9 percent). Finally, these products were followed by the fabrication of the docks (2.9 percent).

The next product category was processed materials (7.8 percent), (Figure 3.7). From the responses, respondents indicated that used treated materials should be processed for further application. The manufacture of mulch was the most frequently mentioned product (61.9 percent), followed by chips and paper products (both at 10.7 percent). Next, respondents mentioned the processing of spent CCA material for fuel fiber (7.1 percent). This was followed by the manufacture of sawdust, process for absorption material, and the production of pet pen mulch (all 3.2 percent).

The next categories included utilizing the spent material for other uses and no utility (both 1.4 percent), (Figure 3.7). Participants also indicated that used material should be given to the less fortunate and that the opportunities for using spent CCA treated material were endless.

Finally, materials handling is the next application category recommended for utilizing spent CCA treated lumber (0.8 percent), (Figure 3.7). In this category, crates and pallets were the primary product mentioned (66.7 percent). And, the manufacture of the dunnage followed (33.3 percent).

Research Summary

The average size of decks is increasing, as the average size of a demolished deck was nearly 198 square feet and a new deck contained approximately 280 square feet. The estimated age of decks was nearly 13 years at removal; this is notably higher than found in previous research.

From data analysis and extrapolation, the estimate is that over 47,000 decks were demolished in the sample states and nearly 709 thousand decks were demolished nationally. Our estimates indicate that about 67.5 million board feet (full sawn) were removed in the sample states. The national estimate of decking lumber removed was 1,013,635,442 board feet, or nearly 84.5 million cubic feet removed in 1999.

The majority of contractors sampled reported building new decks in 1999. There were a large number of contractors that remodeled; and 182 replaced deck boards, 144 replaced deck railings, and 110 replaced deck stair treads. The average cost for demolishing a deck was nearly $180 and the additional costs for dismantling a deck was over two times that, $370 per deck. Results indicated that nearly 35 percent of the lumber removed from a deck could be reused in another capacity. Discards (e.g., end trims, supports) from deck construction averaged roughly seven percent.

The primary factor for replacing a deck was decayed wood. Aesthetics, the physical degradation of wood, and safety followed this closely. Surprisingly, a new deck style preferred and a new material preferred were among the lower rated factors.

The overwhelming majority of contractors disposed of used CCA treated material at MSW landfills. Somewhat surprisingly, over 16 percent of the total respondents reported recovering discarded lumber for reuse, and this was the second most frequently reported disposal method. On a more serious note, 13 percent of the respondents reported the burning of used treated lumber as a disposal method.

When observing the results from the deck recovery importance factors, the most striking results are “lack of recycling programs” and a “lack of recycling facilities.” Other highly rated importance factors are costs, time, and manpower. It should be self-evident that programs and facilities will have to be developed to make the recovery of treated lumber a viable option.

Responses to the qualitative question regarding initiatives or programs to facilitate recovery supported the findings of the recovery importance factors. The largest percentage of responses indicated that financial incentives should be instituted to facilitate the recovery CCA treated lumber. While most were not specific in their response, participants indicated that some type of financial incentive needed to be developed. Incentives that could be developed include tax credits; standardized deductions, reduced or the elimination of landfill tipping fees, and incentives could be based on the pounds or tons of material recovered. Each of these should be considered and could be incorporated to encourage the recovery and recycling of used treated lumber.

The next response category concerned facilities, the overwhelming response was that recovery centers needed to be built and easy access to these facilities was also a requirement. Followed by the establishment of programs was another category frequently mentioned. Respondents indicated that the development of the buyback program should be considered. Other respondents indicated that the industry or government should sponsor pickup programs at the job site.

Another interesting category was education, and participants indicated that public education programs needed to be developed. It was also mentioned that education programs should include methods for demolition or dismantling, material on why the recovery of spent CCA treated lumber was necessary, and literature on potential health risks should be made available.

Qualitative question two concerned products that could be manufactured from used CCA treated lumber. Respondents most frequently indicated that recovered lumber should be utilized in the manufacture of engineered wood composite products. This included several types of engineered lumber, such as microlam, parallam, laminated veneer lumber, and medium density fiberboard. The next most frequently mentioned product was the manufacture of treated orientated strand board.

Participants also indicated using the recovered lumber for outdoor home applications. The most frequent response was to apply the recovered lumber as landscape borders. This was followed by the manufacture of lawn furniture and playground structures, and by other miscellaneous home projects.

Miscellaneous wood products was also a response category, and this category included stakes, forming materials, other lumber products, firewood logs, and posts.

Another category was decking and decking related materials, and included utilizing the recovered lumber in the construction of small decks, the construction of walkways, the manufacture of stair treads, and for use in docks.

Conclusion

This research sought to develop a profile of used CCA lumber recovered from residential decking. This was achieved by gathering and compiling information regarding the construction, demolition, deck replacement components and factors, and recovery factors. In addition, qualitative responses regarding programs and incentives to facilitate recovery, and the potential products that could be manufactured from spent CCA lumber were addressed.

One of the more striking findings was the lack of knowledge regarding the disposal of CCA lumber and potential products that could be manufactured from spent CCA lumber. Obviously certain respondents were completely ignorant regarding the components of CCA, the ramifications of burning used lumber, as well as potential products that included the manufacture of fire logs. This not only has strategic implications towards the recovery of CCA lumber but to marketing in general as well. The primary implications are that marketers should strive to understand the knowledge level of the customers and develop marketing communications campaigns to address the specific knowledge level of the customer.

The results of this research indicate that the cost of dismantling a deck, financial incentives, recovery programs and facilities, a promotional campaign to address the benefits of recycling, all are important factors and issues with the contractor. For the recovery of treated lumber to become a viable alternative to disposal, it is vitally important that we fully understand what contractors will need to begin the recovery of discarded CCA treated lumber. Understanding these needs and contractor attitudes will benefit the producers of Southern yellow pine, the treating industry, consumers, municipalities, and our forests.

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CHAPTER FOUR. Contractors' Attitudes Towards The Recovery Of Used CCA Treated Lumber

Overview

The following chapter examines a modified theory of planned behavior and its constructs, which includes evaluations, beliefs, subjective norms, awareness, and perceived behavioral control. Specifically, how do the constructs influence the contractors' decision intention to recover used CCA treated lumber? The principle objective was to model the factors that influence or shape a contractors intention to recover used CCA treated lumber, and ultimately their behavior to recover used material. The key to predicting a particular recovery behavior lies with the individual's intention to execute he behavior. The conceptual model was analyzed utilizing both a structural equation modeling program (AMOS 4®) and ordinary least squares regression.

Introduction

United States citizens and manufacturers produce over 510 million cubic meters of wood and forest products each year (Haygreen & Boyer, 1996). Americans also consume more wood products per capita than any other people groups on the earth (Natural Resources Defense Council, 2001). One method for extending the life of our wood products and concurrently reducing the demand on our forests is to preservatively treat wood products. The preservative treating of wood, particularly Southern yellow pine, exhibited dramatic growth in the early to mid-1970's. The treating of wood products extends the life of these products and concurrently protects against bacteria, insect, and fungal attacks against wood. Chromated copper arsenate (CCA), a water borne preservative, is the primary preservative treatment chemical used for treating.

To illustrate the extraordinary growth of treated wood products, consider the species group Southern yellow pine. The preservative treating of Southern yellow pine has increased steadily from 600 million board feet (50 million cubic feet) in 1975 to 6.1 billion board feet (508.3 million cubic feet) in the year 2000. Over 5.5 billion board feet per year of Southern yellow pine has been preservative treated since 1996 and topped six billion board feet in 1998. For the past four years, an estimated two billion board feet has been used to fabricate or remodel residential decking, or nearly 38 percent of all Southern yellow pine that is treated (Southern Forest Products Association (SFPA), 2000). Wood products in the Southeast have a greater potential for deterioration because the climate is very conducive for insects, bacteria, and fungi. Additionally, the majority of residential decks are believed to be located in the Southern United States (McQueen & Stevens, 1998).

The benefits of preservative treating wood products should be self-evident; it prolongs the longevity of the wood products, reduces costs to the consumer, and extends the life of our forests. However, there are salient issues on the horizon for CCA preservative treated lumber.

The first issue concerns the quantities of the CCA treated lumber that are currently and are projected to be removed from service. Cooper (1993) projected that nine million cubic meters would be removed in the year 2004 and nearly 18 million cubic meters would be removed by the year 2020. Several other estimates are within the ranges that Cooper projected. The other major problems associated with used CCA treated lumber are: 1) the majority is directed to landfills and consumes available space, 2) the preservative chemicals may leach in the landfills (even lined landfills leak), (Blaisdell, 2000), and 3) landfilled CCA treated lumber could be utilized for other purposes.

To further illustrate the leaching problem, recent work in the State of Florida indicates that arsenic levels exceed the natural levels found in Florida's soils. The natural arsenic level is roughly 0.42 mg/kg and soil samples taken from underneath residential decks averaged over 28.0 mg/kg (CCA-Treated Wood Projects, 2001.) The United States Environmental Protection Agency recommends that soil arsenic levels are not to exceed 0.8 mg/kg in residential areas (cf. CCA-Treated Wood Projects, 2001). The CCA-Treated Wood Projects also found that the metal concentrations in the soil adjacent to decks could be attributed to leaching from only a fraction of the CCA originally present in the deck. In addition, they report that the State of Minnesota recently conducted hearings on the issue of banning CCA treated lumber.

The disposal and recycling of treated lumber is not unlike that of other consumer wastes. For example, in 1970 one American citizen produced nearly 122 pounds of waste and over 208 pounds per day in 1995 (U.S. Bureau of the Census, 1997). The Census Bureau also estimated that only 27 percent of all wastes are recovered. There has been considerable research on the topic of consumer recycling in the United States and elsewhere (e.g., Biswas *et al*., 2000; Taylor & Todd, 1995; DeYoung, 1996; Bagozzi & Dabholkar 1994; Shum *et al*., 1994; Vining & Ebreo, 1992).

Wilson (1996) points out that in the 1990's the objective of many national residue strategies was to make residue management sustainable. Environmental Resources Management (1992) posited that the first priority was to avoid residue production, followed by the minimization of residue quantities produced, then recover, reuse, and recycle the residues, followed by the treatment of the residues, and finally disposal of the residues. Here treatment focuses on the recovery and minimization of quantities requiring final disposal. Wilson (1996) stated that to move away from landfilling and up the residue management hierarchy would require a fundamental change in the behavior of consumers, commerce, manufacturers, and the government.

Recovery and recycling can also be viewed as an opportunity for marketers. In 1971, Kotler and Zaltman referred to social marketing as designing, implementing, and controlling programs that are developed to influence the acceptability of such social ideas. They also stated that social marketing included product planning, pricing, communication, distribution, and marketing research. Shum *et al*. (1994) viewed recycling in the context of the marketing mix. Pieters *et al*. (1998) observed that a research priority is to determine what actually motivates people to recover and recycle.

This research builds on prior recycling research and also strives to further the understanding of the factors that will facilitate recovery. Researchers and practitioners have an essential need to gain an understanding of what influences contractors' decisions most strongly in order to develop strategies and to direct future research.

To frame and research the aforementioned question, a modified version of the theory of planned behavior (Ajzen, 1991) was developed. The theory incorporates both the situational and individual factors that influence a contractors' decision intention to recover spent CCA lumber. The decision intention was the dependent variable, and is defined as the contractors' overall assessment of the utility of recovering CCA treated lumber. It is proposed that by researching the contractors' decision intention, a better understanding of the strengths of these influences on recovery intention and ultimately the behavior would be gained.

In keeping with the constructs and terminology of the theory of planned behavior (Ajzen, 1991), the independent variables of primary interest regarding contractors were: 1) Evaluations and beliefs toward the recovery intention of used CCA lumber, 2) the social influence of others or subjective norms, and 3) perceived behavioral control. Perceived behavioral control can be further delineated into two-components: 3a) internal control factors, and 3b) external control factors. Both involve the situational and individual factors that influence a contractors' decision intention. And finally, 4) awareness regarding the need for the recovery of spent CCA treated lumber, which included both perceived risk and a knowledge item. Figure 4.1 is an adaptation of Ajzen's theory of planned behavior as it relates to this research.

The model indicates that a contractors' decision intention can be affected by their evaluations and beliefs (i.e. attitude), subjective norms, perceived behavioral control, and awareness. The model also illustrates that a contractors' perceived ability to recover used CCA lumber can be moderated by the perceived behavioral control construct. Finally, a contractors' decision intention to recover is hypothesized as evolving from evaluations and beliefs towards recovery, normative beliefs, internal and external control, and awareness.

Objectives

1. Identify attitudes, beliefs, barriers, and incentives towards the recovery and/or initiation of recovery of used CCA treated lumber.

2. Examine contactors' evaluations, beliefs, subjective norms, awareness, and perceived behavioral control based on the contractors' perspective.

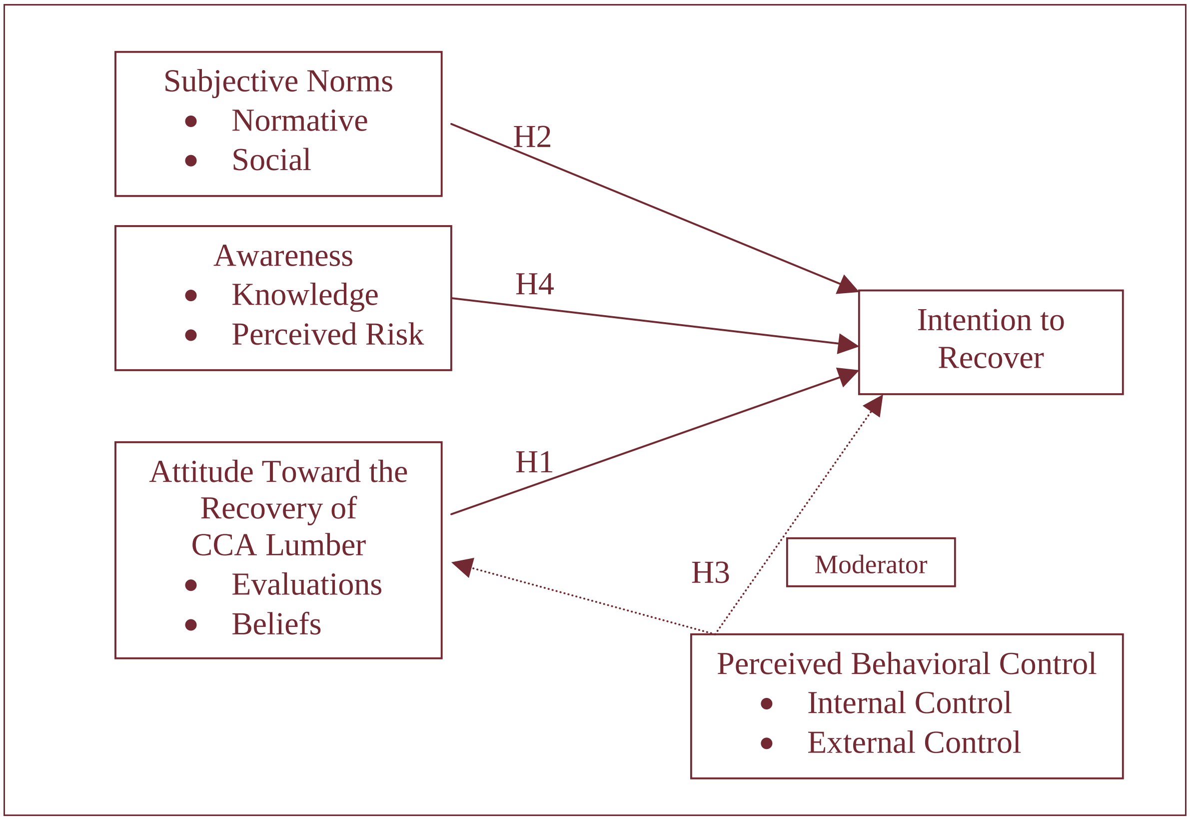

Figure 4.1. A Conceptual Model of Contractors' Decision Intention to Recover CCA Treated Lumber.
Source: The Theory of Planned Behavior, Ajzen (1991).

Theory Development

The theory of planned behavior (Ajzen, 1991) has been used over the past two decades to study a wide variety of behavioral intentions and ultimate behaviors. Central to this theory is a person's intention to execute a specific behavior. Intentions are assumed to capture the motivational factors that influence a specific behavior, and also captures the quantity of effort one plans to apply in order to perform a discrete behavior (Ajzen, 1991).

The gist of this theory is that by predicting intention one can predict behavior. Intention is shaped by attitudes toward a specific behavior (attitude toward an object), the influences of important others (subjective norms), and the perceived level of control over the specific behavior (perceived behavioral control).

Several studies have utilized this theory to study recovery and recycling (e.g., Biswas *et al*., 2000; Taylor & Todd, 1995; DeYoung, 1996; Bagozzi & Dabholkar 1994; Shum *et al*., 1994; Vining & Ebreo, 1992).

Attitude Toward the Recovery Of Used CCA Treated Lumber

Evaluations

The theory of planned behavior (Ajzen, 1991) posits, "an individual's attitude toward behavior is personal and captures his or her positive or negative evaluation of performing the behavior." The attitude-behavior relationship is defined as a "disposition to respond with some degree of favorableness or unfavorableness toward a psychological object." Currently many researchers view "evaluation as a primary component of an attitudinal response and attitude is defined as one's degree of favorableness or un-favorableness about an object" (Fishbein & Ajzen, 1999). Specificity of this theory is essential, and when attitudes are reduced to a specific behavior level, the prediction of behavioral intention and the behavior improves. Specifically, for this study three salient evaluation items were identified. Given the importance of evaluations, the following hypothesis was developed.

Hypothesis 1_A. Contractors' decision intention regarding the recovery of used CCA treated lumber will be influenced positively by the evaluation of their recovery of used CCA treated lumber.

Beliefs

In Fishbein's (1967) theory of attitude, a person's evaluation of an object was determined by "accessible beliefs about an object" and a belief is defined as the "subjective probability that the object has a certain attribute." An accessible belief, as stated by Fishbein (1963), is the "subjective probability associated with a given belief (i.e., belief strength correlates with the frequency with which the belief is emitted spontaneously"), (cf: Ajzen, 1991). Thus, belief strength is defined as the "subjective probability of a connection between the attitude object and the attribute, and the greater the subjective probability, the stronger the belief" (Fishbein & Ajzen, 1975).

As alluded to earlier, specificity is critical to the theory of planned behavior, and attitude can be influenced by a unique set of beliefs. In view of this, the relevant belief issues developed were drawn upon qualitative interviews and pre-testing conducted with contractors and deck builders. In particular, two salient belief issues were identified. These issues included recovery programs and facilities concerning the necessary for the recovery of treated lumber. With this knowledge regarding beliefs in attitude formation, the following hypothesis was developed:

Hypothesis 1_B. Contractor evaluations regarding the recovery of used CCA treated lumber will be influenced positively by their belief level toward the recovery of used CCA treated lumber.

Subjective Norms

Ajzen (1988) defined the construct as being primarily associated with the influence of others or social pressure, and is termed "subjective norms." Subjective norms or normative beliefs concern the likelihood that significant individuals, coworkers, or groups approve or disapprove of an individual performing a specific behavior. Subjective norms typically are measured by directly asking participants to indicate whether important others would approve or disapprove of their performing a particular behavior (Ajzen, 1991). Researchers using this construct have often found that subjective norms had minimal impact on behavioral intentions as compared to other constructs in the model (Chamberlain, 2000; Biswas *et al*., 2000; Kurland, 1995). For example, Chamberlain (2000) discerned that subjective norms failed to predict intention. Despite the subjective norms inconsistency, environmental psychology research has generally supported the influence of social norms on environmental behaviors (DeYoung, 1996; Vining & Ebreo, 1992). As a result of contractors making decisions in the social context, the following hypothesis was formulated:

Hypothesis 2. Contractors' decision intention regarding the recovery of used CCA treated lumber will not be influenced either negatively or positively by contractors' assessment of significant others.

Perceived Behavioral Control

Ajzen (1985) surmised that a particular behavior might be beyond a person's volitional control. Perceived behavioral control beliefs concern the absence or presence of the necessary resources and opportunities to execute a behavior. Perceived behavioral control refers to an "individual's perception of the ease or difficulty of performing a discrete behavior" (Ajzen, 1991). With a sufficient degree of actual control over a behavior, an actor is expected to execute his or her intention when the opportunity arises (Fishbein & Ajzen, 1999).

Ajzen's (1991) theory recognizes that even the most fervent intention may be constrained by dispositional (internal) and situational (external) control factors. Ajzen also states that perceived behavioral control was similar to Bandura's (1977) self-efficacy theory. Bandura's theory reasons that a person's self-referent thoughts are the foundation of one's perceived control over a situation. Cervone (2000) stated, "People actively weigh the relation between their perceived skills and the demands of tasks when thinking about their capabilities for performance." Additionally, Ajzen (1991) states, "An interaction between intention (motivation) and perceptions of behavioral control can occur and this action is a component of predicting behavior."

Specifically, Ajzen differentiated between internal and external control as they relate to the perceived behavioral control construct (Ajzen & Madden, 1986). Internal control factors are defined as individual dispositional factors and include the quantity of information a person has, a person's skills, economic capability, emotions, and motivation concerning a specific behavior (Ajzen, 1988). Drawing upon qualitative interviews and pre-testing with contractors and deck builders, relevant perceived behavioral control factors were developed.

Internal Control - Self-Efficacy

Ajzen (1991) described the internal perceived behavioral control construct as a person's expectancy about whether he or she can successfully perform the behavior in question. In this research, internal control concerned whether contractors had the time and manpower (Would you haul used CCA lumber farther?), and with their ease or difficulty in beginning the recovery of used lumber. Therefore, it was proposed that contractors with high levels of self-efficacy could assess the factors associated with the recovery of spent CCA treated lumber. The hypothesis is as follows:

Hypothesis 3_A. Contractors' decision intention and evaluation regarding the recovery of used CCA treated lumber will be moderated by internal control.

External Control - Facilitating Conditions

Ajzen (1988) defined external control as the factors, which "… determine the extent to which circumstances facilitate or interfere with the performance of the behavior." Cervone (2000) stated that a person is not likely to act if there is doubt in his or her capability to perform the desired behavior. Taylor and Todd (1995) described the external control component as "facilitating conditions," such as access to a compost box in their study of composting behavior. In this study, external control factors included recovery programs and recovery facilities. The external control factors were identified through both qualitative and pre-testing. Thus, the following hypothesis was formulated:

Hypothesis 3_B. Contractors' decision intention and evaluation regarding the recovery of used CCA treated lumber will be moderated by external control.

Awareness

Awareness or knowledge, has been researched in recycling by several researchers. Most notable is Oskamp *et al.* (1991), who discovered that recyclers were more knowledgeable than non-recyclers with issues concerning environmental conservation. Vining and Ebreo (1992) studied specific aspects of knowledge and recycling; in all three studies, knowledge failed to predict actual recycling behavior. Additionally, contractors were asked if there would be health risks associated with dismantling a deck. Not addressing theses issues would have diminished this study’s practicality. During the qualitative interviews and pre-testing, contractors inquired as to why there was a need to recover and recycle used CCA lumber? The awareness hypothesis developed is:

Hypothesis 4. Contractors' decision intention regarding the recovery of used CCA treated lumber will be positively influenced by their level of awareness.

METHODOLOGY

Population

Contractors associated with the fabrication, demolition, and deconstruction of residential decks were the population of interest for this study. The contractors sampled for this research were from the States of Georgia, North Carolina, and South Carolina.

Sample Frame

The sample frame was obtained from the American Business Disc 2000 (InfoUSA, 2000), which listed a total of 5,902 contractors (with the capability to construct decks) in GA, NC, and SC (Harmonized System Codes (HS) 15 and 17). The sample drawn was from randomly selected deck and patio builders, deck builders, and also included homebuilders, carpenters, handymen, fence contractors, and general contractors located in the sample states. Response rates for studies of these particular professions have been low, ranging from 6 to 14 percent (e.g., Eastin *et al*., 1999; Kozak & Cohen, 1999; McQueen & Stevens, 1998).

Potential respondents were selected by utilizing a simple random sampling method and the sample was developed according to the minimum number of required subjects to ensure the appropriate use of a structural equation modeling program. Hair *et al*. (1999) suggested that the minimum number of subjects received (to conduct proper analysis) was 100.

The number of questionnaires mailed were based on the assumption of a seven percent response rate, twelve percent of the surveys being undeliverable, and a minimum of 100 subjects required for analysis. And based on these assumptions, a total of 2,262 questionnaires was the minimum number of questionnaires to be mailed. In order to facilitate a proper sample being achieved, an additional 224 builders were included in the sample. In addition, 347 patio and deck builders (deck building was listed as their primary occupation) were included in the sample. This resulted in 2,833 questionnaires mailed to the randomly selected members from the sample frame.

Questionnaire Development

The questionnaire was designed to gather data regarding evaluations, beliefs, normative beliefs, perceived behavioral control, awareness, and recovery factors regarding used CCA treated lumber.

Prior to final questionnaire development, contractors were contacted through personal visits in the Commonwealth of Virginia and the State of Maryland, and by phone to solicit their thoughts regarding the recovery of used CCA lumber. Critical issues were ascertained by asking participants to list attributes of an attitude object; here the object regarded the recovery of treated lumber. In addition, participants were queried on several other factors believed to influence recovery. After this process, specific questions within the questionnaire were designed to meet research objectives.

Additionally, scholars from Virginia Tech and personnel from the U.S. Forest Service Southern Research Station assisted in the questionnaire development.

Pretest

The questionnaire was pre-tested during the spring of 2000 via a mail and facsimile survey. Respondents were asked to identify questions that may have been troublesome to answer and for their input regarding question wording. Eighteen contractors from the Commonwealth of Virginia responded to the pretest.

One of the major findings of the pretest and qualitative interviews was that the recovery of spent CCA treated lumber was not a pressing issue and was not being practiced among contractors (the recovery of used lumber was ascertained to be insignificant among contractors.) The recovery of used lumber (as a behavior) was not considered to be a relevant item to measure for the study; therefore the behavior component of the theory was not included in the revised model or in the questionnaire. Of the twenty items pretested, 15 items loaded on four factors. Specifically, seven items loaded on factor one (evaluations, beliefs, subjective norms); six items on factor two (internal control, health risk, awareness), and two items on factor three (external control). Factor four contained the fewest items and they were determined not to be theoretically relevant, and were dropped.

In order to measure evaluations, three items were retained for evaluations and two for beliefs. Additionally, two items were retained for both the subjective norms and awareness, and six items were retained for perceived behavioral control.

The pretests aided in the development of the items designed to capture the contractors' decision intention. After modifications the questionnaire was finalized for printing. A discussion of variable measurement, data collection, and analysis follow.

Measurement of Variables

Contractors' Decision Intention to Recover CCA Treated Lumber

Drawing upon examples from Ajzen (1991), one item was used to measure the contractors' recovery decision intention. This item was measured with a bipolar scale (-3 to 3) and anchored with the adverb qualifiers "Quite likely" and "Quite unlikely." This item was straightforward and presented the contractor with the likelihood of them beginning the recovery of spent CCA treated lumber. Higher scores indicate that contractors are more favorable towards the recovery of spent CCA treated lumber.

Evaluations

Three items were developed for this study to assess contractors' evaluation of recovering spent CCA treated lumber. Scale design conformed to past research of the theory of planned behavior (Ajzen, 1991). A bipolar scale (-3 to 3) was utilized for evaluation items and the items were anchored with the adverb qualifiers "Extremely favorable" and "Extremely unfavorable."

Beliefs

Two items were used for beliefs and the scales were modeled similar to work conducted by Ajzen (1991). The items were measured with a bipolar scale (-3 to 3) and were anchored with the adverb qualifiers "Strongly agree" and "Strongly disagree."

Subjective Norms

Two items were developed to assess contractors' subjective norms concerning the recovery of spent CCA treated lumber. Scale design conformed to past research of the theory of planned behavior (Ajzen, 1991). A bipolar scale (-3 to 3) was utilized for the subjective norm items and the items were anchored with the adverb qualifiers "Strongly agree" and "Strongly disagree."

Perceived Behavioral Control: Internal Control

Four items were used to measure the perceived internal control items and the scales were modeled similar to Ajzen's research (1991). The remaining items utilized in the analysis were measured with a bipolar scale (-3 to 3), and were anchored with the adverb qualifiers "Strongly agree" and "Strongly disagree."

Perceived Behavioral Control: External Control

Two items were developed for this study to assess perceived contractors' external control regarding recovering used CCA treated lumber. Again, scale design conformed to past research of the theory of planned behavior (Ajzen, 1991). A bipolar scale (-3 to 3) was utilized, and the items were anchored with the adverb qualifiers "Strongly agree' and "Strongly disagree."

Awareness

Two items were used to assess contractor awareness. The first item involved a perceived health risk and the second concerned knowledge. Specifically, a question was constructed to assess contractors' knowledge regarding the need for the recovery of spent CCA treated lumber. During the questionnaire mailing sequence, we received calls from contractors asking, "What is CCA treated lumber?" And other participants asked, "What are the health risks?" Another respondent stated that "The quantities of CCA treated lumber utilized in construction are minimal and there was not a need for this study." A bipolar scale (-3 to 3) was utilized for the awareness items and the items were anchored with the adverb qualifiers "Strongly agree" and "Strongly disagree."

Data Collection Process

The primary data collection tool was a self-elicitation mail survey questionnaire. The mail survey and sequencing were modeled after Dillman's (1978) Total Design Method. A pre-notification letter (Appendix A) was mailed on July 25, 2000, two weeks before the questionnaires were mailed. The purpose of the letter was to explain the nature of the research and to request and encourage them to participate in the research. In addition, a financial reward (a $200 gift certificate from the Home Depot™) was offered to the participants in order to increase the response rate. Two weeks after the pre-notification letter was mailed, the questionnaire (Appendix B) packet was mailed on August 9, 2000. This included a cover letter and the questionnaire form. Two weeks after the initial questionnaire package was mailed, a reminder postcard (Appendix C) was mailed to the non-respondents. The postcard encouraged non-respondents to participate in the research and thanked the respondents for replying to the survey.

A re-mailing of the entire package to the non-respondents occurred four-weeks after the initial mailing. Again, a reminder postcard was mailed to non-respondents two-weeks later. In mid-October, a cover letter pleading for non-respondent participation and questionnaire were mailed again to the non-respondents. After a two-week period, a reminder postcard was mailed to the non-respondents. In total, the randomly selected contractors were sent seven mailings (if they did not respond to the survey).

Data Analysis

The returned questionnaires were examined for completeness and usability. Questionnaires deemed acceptable were coded and entered into the SPSS® statistical analysis spreadsheet.

The first phase entailed executing descriptive statistical techniques to check for incorrectly entered items. Secondly, checks for skewness, kurtosis, and normality were conducted.

Next, frequency distributions and arithmetic means were produced for contractor beliefs, evaluations, perceived barriers, and factors concerning recovery. Fourth, a maximum likelihood factor analysis was executed, and reliability analysis was conducted after the completion of factor analysis. Finally, for model analysis both AMOS 4® and ordinary least squares regression were utilized.

To gain an understanding of the differences or similarities among the builders of decks, the respondents were segmented into two separate groups. Group one (full-time deck builders) was comprised of respondents whose primary occupation was listed as deck building (Harmonized System code). The second group (part-time deck builders) was comprised of contractors and others whose primary occupation was not listed as deck building, but they did build decks. Full-time deck builders contained 115 subjects and the part-time deck builder group was comprised of 264 subjects.

Results and Discussion

Data Normality

The analysis indicates that both the skewness and kurtosis values were within acceptable levels were skewness values are ≤ 2.0 and kurtosis values ≤ 2.0 (Brinberg, 1999; Coakley, 1999), (Table 4.1).

Table 4.1. Normality Statistics for Model Items.

Item	Skewness	Kurtosis
General evaluation	-0.94	0.55
Recovery evaluation	-1.25	1.50
Beneficial evaluation	-0.98	0.76
Recovery belief	-0.69	0.11
Beneficial belief	-0.80	0.54
Centers available	1.20	0.57
Programs in place	1.36	1.25
Time	0.35	-0.95
Manpower	0.29	-1.09
Intention	-0.48	-0.54
Guilty	-0.59	-0.26
Others expectations	0.13	-0.49
Need to recover	-0.57	-0.15
Health risk	-0.08	-0.03

In addition, a plot of the regression residuals indicates that the residuals exhibit characteristics of a normal distribution. Analysis of the standardized regression residuals yielded a value of 0.91 for skewness and 1.71 for kurtosis (Figure 4.2).

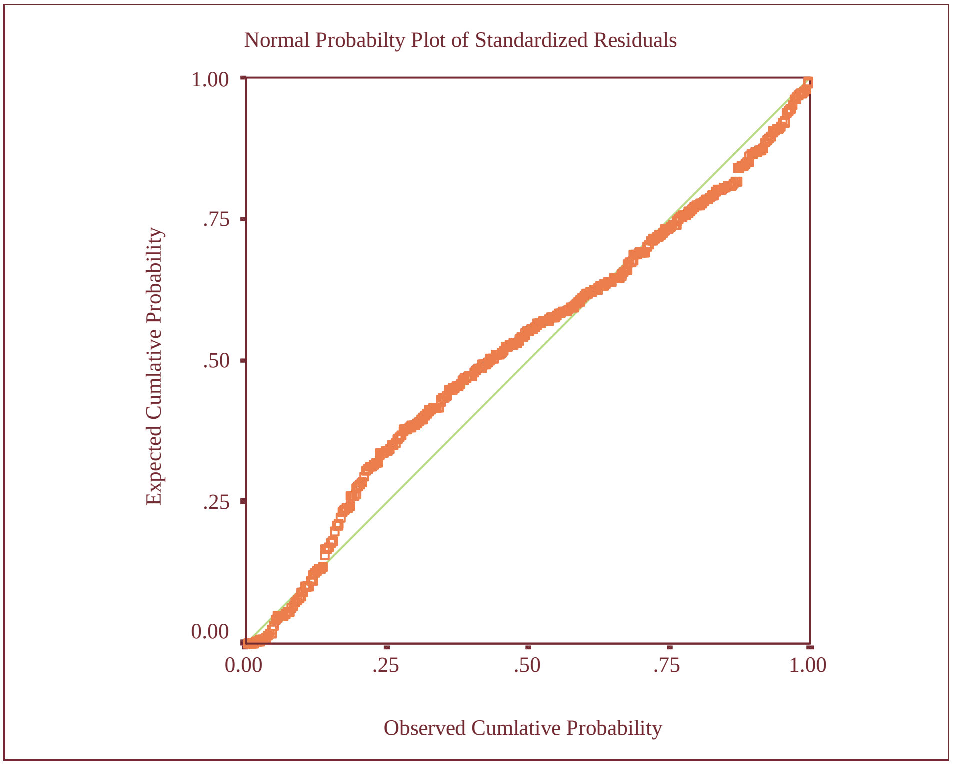

Figure 4.2. Plot of Standardized Regression Residuals.

Response

The questionnaires were mailed to 2,833 contractors in the selected states. From these, 681 were returned as undeliverable or refused. Undeliverable questionnaires included contractors that had gone out of business, contractors that moved without a forwarding address, or certain contractors that had an expired forwarding address. Three respondents refused the final mail survey questionnaire packet. Ten companies requested by phone or by letter to be removed from the study. This resulted in a total of 2,139 contractors as potential respondents. In total, 580 questionnaires were returned. The first question asked the respondent if their company fabricated decks. One hundred and eighty respondents answered *No*, and *Yes* was checked by 400 respondents.

Twenty-one of the returned surveys were deemed unacceptable for model analysis (participants did not completely answer the model items). Therefore the aforementioned responses were not utilized in the analysis. This resulted in 379 usable survey questionnaires and the minimum number of subjects required for model analysis was 100. The total adjusted response rate was calculated by subtracting the bad addresses from the mailing total and dividing it into the usable responses. The total adjusted response rate was 27.1 percent.

Non-Response Bias

To ensure the validity of the research, non-response bias procedures were employed. Contractors that did not respond to the mail survey questionnaire were randomly selected and contacted by phone. These individuals were asked five pre-selected questions from the questionnaire. A total of 30 responses were collected for the non-response bias investigation. An independent samples student t-test was executed to discern if there were statistical differences between respondents and non-respondents on the pre-selected questions. There were no significant differences detected on four of the questions.

The question that resulted in a significant difference asked respondents, "In your opinion, what percentage of decks are repaired or built by the homeowner?" This statistical finding may be due to the wording of the question, as the question should have been two separate and distinct questions. Additionally, the Armstrong-Overton (1977) wave analysis method was employed and contrasted the first 30 respondents against the last 30 respondents. No statistical differences were discovered utilizing this method (α = 0.05).

Demographics

Descriptive Statistics - Means, Standard Deviations, and Correlations

Evaluations

Concerning evaluations, the recovery evaluation ("… if recovery centers were available") was rated highest at 1.55, followed by the beneficial evaluation ("The recovery of used treated lumber is a beneficial act"), and the "general evaluation" (Figure 4.3, Table 4.2). The results of the evaluation questions are encouraging, while the ratings were not extremely high, they were positive.

All of the evaluation items were highly and significantly (α = 0.01) correlated with each other (Table 4.2). It also should be noted that the beneficial belief is also strongly correlated with the need to recover, appearing to indicate that contractors believe that there is a need to recover used CCA treated lumber.

Beliefs

Regarding beliefs, the beneficial belief ("The recovery of used lumber is a beneficial act") was rated at 1.29, and recovery belief ("I believe if recycling programs or centers were available I would recover") rated 1.08 (Figure 4.3, Table 4.2). Both belief items correlated very strongly with the appropriate evaluation items. While the belief means were positive, they are low to moderate at best. These findings appear to indicate that with the proper message, and in conjunction with other components of the recovery process, recovery could become a viable alternative to disposal.

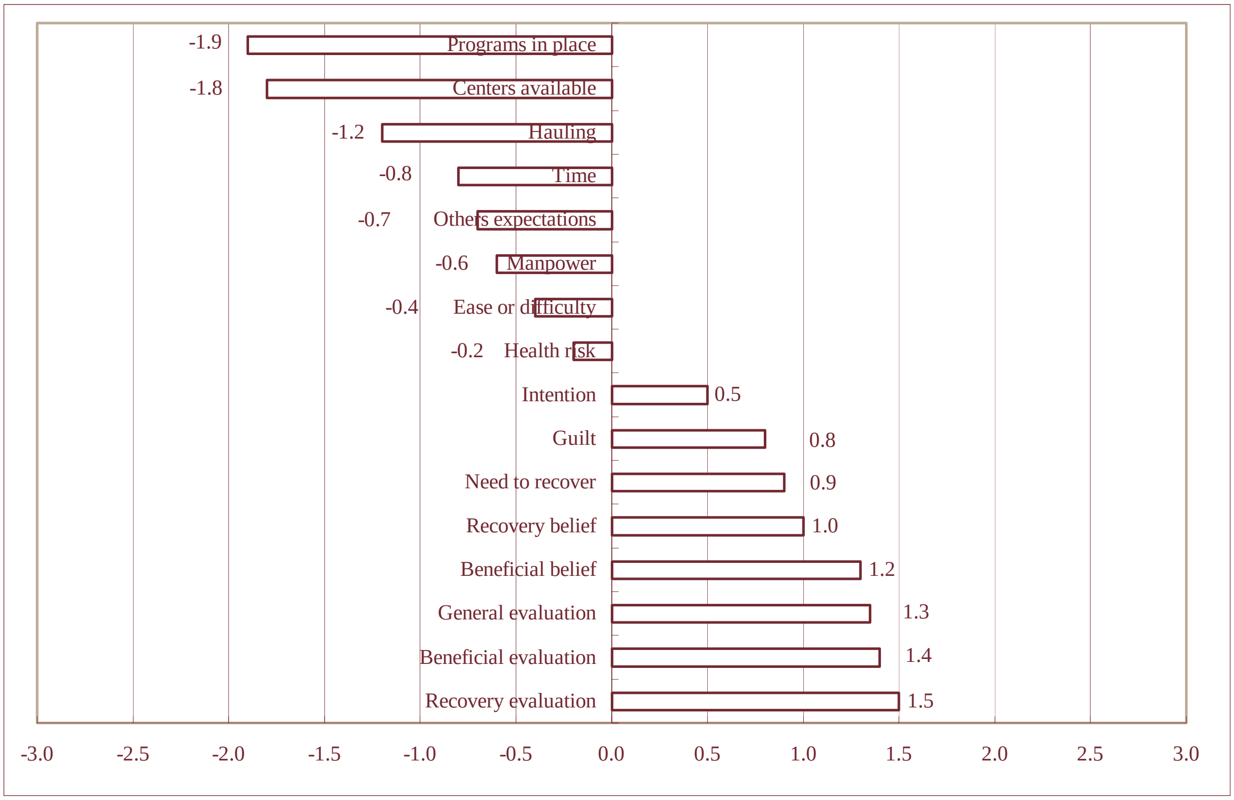

Figure 4.3. Chart of Model Item Means.

Subjective Norms

The respondents were also asked to evaluate two subjective norm items. The first item concerned other's expectations ("… co-workers expect me to recover") and rated (-0.69). Next, a personal norm item was measured ("I would feel guilty if recycling centers were available and I did not recover") and the mean rating was 0.80 (Figure 4.3, Table 4.2).

Here, the influence of co-workers appears not to be a concern for the respondents. The "guilty" finding was slightly positive, which may indicate that if convenient facilities and programs were established, contractors may begin recovery.

Regarding subjective norms, "guilty" was most strongly correlated with both the recovery and beneficial beliefs, signifying that the participants may be somewhat inclined to believe that the recovery of spent CCA treated lumber is necessary (Table 4.2).

Perceived Behavioral Control

External Control

Contractors were asked six items regarding perceived behavioral control. Participants were asked if the recovery centers were available, would they begin recovery, and the mean rating was (-1.84). The next item asked respondents if there were currently any programs in place to begin the recovery of used lumber, the mean rating was (-1.98). These response means were not unexpected; clearly the programs and facilities need to be developed in order to facilitate the recovery of used lumber (Figure 4.3, Table 4.2).

The correlations for "centers available" were nearly neutral, with the only significant correlation occurring with the "ease or difficulty" item. Intuitively, this should suggest that recovery centers will have to be established (that are easily accessible) to assist in the recovery process. Likewise, "programs in place" was not highly correlated with most items, with the exception of "centers available" (Table 4.2). Again, this appears to provide support for both recovery centers and programs being established in order to facilitate the recovery of spent CCA treated lumber.

Internal Control

The first question asked participants if they would "haul used treated lumber a greater distance than other construction debris" and the mean rating for "hauling distance" was (-1.22), (Figure 4.3, Table 4.2). Obviously centers will have to be located near existing facilities or some other type of transportation and pickup method be employed. The second question concerned the "ease or difficulty" in beginning the recovery of used treated lumber (-0.42). The next item asked respondents if they had the "time" to recover used lumber and this rated (-0.78). And finally respondents were asked if they had the manpower to begin the recovery of used CCA treated lumber, and the mean rating was - 0.59. While the manpower rating was slightly negative, it appears not to be a problem if and when other recovery components are instituted.

"Hauling distance" was most strongly correlated with "ease or difficulty," indicating that participants may be inclined to begin recovery if centers are made available and within close proximity to their respective community. This may also indicate that the economics of recovery are involved, as both time and equipment costs may factor into the recovery process. "Time" was strongly correlated with both "ease or difficulty" and ‘‘recovery belief."

Economics (i.e., time and manpower) may factor into the decision to begin the recovery of used lumber, and may also indicate that beliefs are linked in much the same manner, with economic considerations. The "manpower" item very strongly correlated with "time" and strongly correlates with "ease or difficulty." Again, this indicates that economics may play a central role in the recovery process. And this also lends additional support for the development of facilities and programs being established to facilitate the recovery of used treated lumber (Table 4.2).

Awareness

Finally, the awareness component was analyzed and was comprised of two items, one concerning knowledge and the other regarding health risk. The knowledge item ("There is a need to recover used lumber") rating was 0.86. Health risk or "the recovery of used lumber poses a health risk" rating was (-0.19), (Figure 4.3, Table 4.2). It appears respondents consider working with used CCA lumber not to be a health risk.

The knowledge item correlated strongly with both the "recovery and beneficial beliefs." This lends support to the development of an appropriate promotional message that details the facts as to why the recovery of used CCA lumber is necessary. As for "health risks," this item did not correlate significantly with any variable and was nearly neutral on all items (Table 4.2).

Contractors' Decision Intention

The contractors' decision intention to recover used CCA treated lumber mean rating for intention was 0.50 (Figure 4.3, Table 4.2). This result was not unexpected, as there is no impetus either by contractors or by local governments to begin the recovery of the CCA lumber.

Table 4.2. Means, Standard Deviations, and Correlations [1, 2, 3] Among All Variables.

#	Item	**Mean**	**S. D.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	General evaluation	1.38	1.48															
2	Recovery evaluation	1.55	1.42	0.764														
3	Beneficial evaluation	1.40	1.45	0.692	0.796													
4	Need to recover	0.86	1.60	0.352	0.412	0.497												
5	Health risk	-0.19	1.48	***-0.05***	***-0.094***	***-0.090***	***0.004***											
6	Recovery belief	1.08	1.51	0.508	0.651	0.641	0.482	***-0.016***										
7	Beneficial belief	1.29	1.43	0.519	0.626	0.705	0.553	***-0.008***	0.732									
8	Guilty	0.80	1.67	0.297	0.298	0.305	0.333	***0.044***	0.450	0.423								
9	Others expectations	-0.69	1.62	0.136	0.162	0.230	0.205	0.124*	***0.136***	0.210	0.216							
10	Ease or difficulty	-0.42	1.77	0.277	0.257	0.312	0.332	***0.019***	0.346	0.311	0.211	0.272						
11	Centers available	-1.84	1.52	***0.079***	***0.055***	***0.038***	***0.081***	***0.086***	***-0.005***	***-0.008***	***-0.047***	0.196	0.228					
12	Programs in place	-1.98	1.39	***0.029***	***0.010***	***-0.005***	***-0.011***	***0.015***	***-0.032***	***-0.046***	***-0.060***	0.113*	0.087	0.630				
13	Hauling distance	-1.22	1.71	0.149	0.171	0.185	***0.087***	***0.001***	0.188	0.171	0.109*	0.110*	0.231	0.157	0.180			
14	Time	-0.78	1.77	0.296	0.302	0.303	0.331	***-0.049***	0.424	0.371	0.331	0.153	0.532	***0.055***	***0.076***	0.342		
15	Manpower	-0.59	1.89	0.320	0.309	0.321	0.332	***-0.075***	0.407	0.373	0.312	0.129*	0.508	***0.094***	***0.049***	0.296	0.820	
16	Intention	0.50	1.78	0.468	0.502	0.496	0.466	***0.045***	0.582	0.550	0.377	0.297	0.529	0.184	***0.072***	0.160	0.462	0.444

1. Non-italicized correlations are significant at the alpha = 0.01 level.
2. Correlations with an asterisk (*) are significant at the alpha = 0.05 level.
3. Italicized and bold correlations are not significant at the alpha = 0.01 or 0.05 level.

“Intention” was significantly correlated with several items, most salient were the “recovery and beneficial beliefs,” “ease or difficulty,” and the “recovery evaluation” (Table 4.2). The most striking finding from correlation analysis was that neither “centers available” or “programs in place” were not more strongly correlated with intention. While both these items were significantly correlated with intention, the resultant correlations were not as strong as other items. This finding may be due to the lack of current recovery among contractors and that facilities and programs do not exist. Therefore, at this point in time, it appears that current contractor beliefs signify that although recovery is important, the facilities and programs are not in place for them to begin recovery.

Using bivariate correlations as a preliminary test of the relationships between the independent variables and the contractors’ decision intention, it was found that evaluation, beliefs, and the perceived behavioral control items appear to be significant predictors of the contractors’ decision intention.

Contrasts of Groups

Statistical comparisons were made between full-time and part-time deck builders on all items. The alpha level for all of the contrasts was 0.05. First, the groups were contrasted on the evaluation items, and significant differences were not found on the evaluation questions. The second contrast involved the belief items and there was no evidence that the groups differed on the belief questions. Next, no significant differences were found between the groups regarding subjective norms (Table 4.3).

Fourth, comparisons were made between groups on the internal control items, and no significant differences were discerned. Fifth was the external control contrast and there was very significant evidence that the groups differed on “centers are available” (p = 0.02) and on “are programs in place” (p = 0.02). These statistical differences may be attributed to the fact that full-time deck contractors are more directly involved with decking and CCA treated lumber, and therefore know that centers and programs are not available. There were no significant differences found between the groups regarding the awareness items or intention (Table 4.3).

Table 4.3. Contrasts of Full-Time versus Part-Time Deck Builders on Model Items.

Item	n	Full-time Mean	n	Part-time Mean	t-statistic	p-value
General evaluation	115	1.2	264	1.43	1.6	0.10
Recovery evaluation	115	1.4	264	1.58	1.2	0.22
Beneficial evaluation	115	1.3	264	1.43	0.9	0.39
Need to recover	115	0.8	264	0.89	0.6	0.57
Health risk	115	-0.3	264	-0.16	0.8	0.44
Recovery belief	115	1.0	264	1.07	0.2	0.81
Beneficial belief	115	1.2	264	1.34	0.9	0.38
Guilt	115	0.8	264	0.81	0.2	0.83
Others expectations	115	-0.8	264	-0.66	0.7	0.49
Ease or difficulty	115	-0.5	264	-0.38	0.7	0.43
Centers available	115	-2.0	264	-1.68	2.3	0.02
Programs in place	115	-2.2	264	-1.85	2.3	0.02
Hauling distance	115	-1.2	264	-1.22	-0.0	0.99
Time	115	-0.7	264	-0.81	-0.6	0.54
Manpower	115	-0.5	264	-0.61	-0.3	0.79
Intention	115	0.3	264	0.55	1.4	0.17

Factor and Reliability Analysis

A maximum likelihood factor analysis was conducted to discern the relevant items regarding recovery. Results from a three factor solution indicated that nearly 60 percent of the variance was explained (Table 4.4). Analysis indicated that the constructs loaded on the appropriate factors, an indicator of convergent validity (Table 4.5). Convergent validity refers to the principle that the indicators for a given construct should be at least moderately correlated among themselves or the items designed to measure the construct should all "converge" on the same factor. Deficient convergent validity among the indicators for a given factor may indicate that the model needs to have more factors or is poorly designed.

Table 4.4. Factor Analysis - Theory Items.

Initial Eigenvalues			
Factor	**Total**	**Percent of Variance**	**Cumulative Percent**
1	5.75	35.94	35.94
2	2.05	15.84	51.78
3	1.42	8.85	60.64

Evaluations – All three-evaluation items loaded highly on factor one, general (0.762), recovery, and beneficial (Table 4.5). Both the recovery and beneficial evaluation items were utilized in the model analysis. Concerning reliability analysis, the Cronbach's alpha for these items was nearly 0.90.

Beliefs – Both of the belief items loaded highly on factor one, recovery at 0.710 and beneficial at 0.750 (Table 4.5). Both of the belief items were included in the model analysis, and results of reliability analysis yielded a Cronbach's alpha of 0.85.

To assess discriminant validity, confirmatory factor analysis (Jöreskorg & Sorbom, 1989; Fornell & Larcker, 1981) was employed, and the results did provide support that evaluations and beliefs are distinct constructs. In order to examine that evaluations and beliefs were discrete constructs, both factor analysis and AMOS 4® (Arbuckle, 2000) were employed.

Table 4.5. Factor Loadings[1, 2] of the Independent Variables.

Item	Factor 1	Factor 2	Factor 3
General evaluation	***0.762***	0.149	0.032
Recovery evaluation	***0.877***	0.130	0.075
Beneficial evaluation	***0.877***	0.147	-0.027
Need to recover	0.519	0.284	0.056
Health risk	-0.058	-0.032	0.064
Recovery belief	***0.710***	0.321	-0.064
Beneficial belief	***0.750***	0.259	-0.056
Guilty	0.346	0.288	-0.079
Others expectations	0.214	0.147	0.165
Ease or difficulty	0.260	0.545	0.178
Centers available	0.037	0.123	***0.991***
Programs in place	-0.017	0.108	***0.657***
Hauling distance	0.132	0.332	0.126
Time	0.190	***0.919***	-0.037
Manpower	0.216	***0.845***	-0.000

1. Extraction Method: Maximum Likelihood.
2. Rotation Method: Varimax with Kaiser Normalization.

Regarding convergent validity, both the evaluation and belief items were forced into a two factor solution (Table 4.6). The results indicate that the items loaded on separate factors and the resulting Pearson Chi Square (χ^2) was 4.143, with a p-value of 0.04 ($\alpha = 0.05$). This would indicate that evaluations and beliefs are distinct constructs.

Table 4.6. Confirmatory Factor Analysis[1, 2] of the Evaluation and Belief Constructs

Item	Factor 1	Factor 2
Recovery evaluation	**0.873**	0.365
Beneficial evaluation	**0.699**	0.503
Recovery belief	0.480	**0.617**
Beneficial belief	0.325	**0.945**

1. Extraction Method: Maximum Likelihood.
2. Rotation Method: Varimax with Kaiser Normalization.

Next, both constructs were then evaluated by using AMOS 4®. Initially the evaluation and belief items were run in a totally unconstrained model, resulting in a χ^2 of 42.6, with three degrees of freedom (df). Next, the items were compared in a fully constrained model and this yielded a χ^2 of 51.7, and df's = four. The change in the χ^2 was 9.1, df = one; this is significant at the χ^2 critical value of 3.841 ($\alpha = 0.05$). This also lends support that both evaluations and beliefs are discrete constructs.

Subjective Norms – The results from factor analysis reveal that neither subjective norm item loaded highly, and both loaded on factor one, guilty (0.346) and others expectations (0.214), (Table 4.5). The Cronbach's alpha for these items was 0.36. As a result of both analyses, both of the subjective norm items were dropped from the structural equation model analysis.

Awareness - The results of factor analysis revealed that neither of these items loaded in a manner to be included in the structural equation model analysis. The need to recover loaded highest on factor one (0.519) and health risk loaded positively on factor three (0.064), (Table 4.5). Additionally, reliability analysis resulted in a Cronbach's alpha of 0.01 for the two-items.

Perceived Behavioral Control, Internal Control - Factor analysis revealed that both time and manpower loaded highly on factor two (0.919 and 0.845). Neither ease or difficulty or hauling distance loaded highly, and both loaded on factor two as well (Table 4.5). The four item Cronbach's alpha was 0.77, after the deletion of both the hauling distance and ease or difficulty items; the resultant Cronbach's alpha was 0.90. Time and manpower were retained for both regression and the structural equation model analysis.

Perceived Behavioral Control, External Control – Centers available and programs in place loaded on factor three (Table 4.5), and reliability analysis resulted in a Cronbach's alpha of nearly 0.80.

Regarding discriminant validity, subsequent analysis did provide support that both the internal and external control items are distinct constructs. Again, both factor analysis and AMOS 4® were employed. As a result of having negative degrees of freedom, factor analysis could not be conducted. However, both constructs were evaluated by using AMOS 4®. Initially, the internal and external control items were run in a totally unconstrained model, resulting in a χ^2 of 5.1, with one df. Next, the items were compared in a fully constrained model and this yielded a χ^2 of 24.8, df's = two. The change in the χ^2 was 19.7, df = one; this is significant at the χ^2 critical value of 3.841 ($\alpha = 0.05$) with one df. This finding indicates that both the internal and external control items are discrete constructs.

Results of Hypothesis Tests

The results of the hypothesis tests are presented in the following manner. First, evaluations effect on contractors' decision intention was examined. All raw data was mean-centered for both the hypotheses and model analysis in regression (this procedure is performed to reduce the affects of multicollinearity.)

Hypothesis one posits that decision intention will be positively influenced by the evaluation of recovering spent CCA treated lumber. Specifically, decision intention is affected by the contractors' overall evaluations of recovery. Finally, each hypothesis will be examined in order of presentation.

Hypothesis One

Hypotheses One A ($H1_A$) states that the decision intention regarding recovery will be influenced positively by their evaluation of recovery. Hypotheses One B ($H1_B$) posits that contractors' evaluations concerning the recovery of spent CCA treated lumber will be influenced positively by beliefs. For these analyses, ordinary least squares regression was utilized with decision intention as the dependent variable for $H1_A$, and evaluation as the dependent variable for $H1_B$.

The independent variables used for $H1_A$ included the combined recovery and beneficial evaluations to form the evaluation variable. Regression analysis indicated that evaluation does have a significant impact on contractors' decision intention (Table 4.7). The results included a squared multiple correlation (r^2) of 0.269, with a $F_{(1, 378)} = 139.19$, and $p < 0.01$. The results provide support that decision intention is positively affected by contractors' evaluation of recovering CCA treated lumber.

Table 4.7. Regression Analysis of Hypothesis 1_A – Evaluation on Decision Intention[1].

Item	Unstandardized Beta	Beta	t-statistic	p-value
constant	-1.631		-19.413	< 0.01
Evaluations	0.685	0.519	11.798	< 0.01

1. Dependent Variable – Decision Intention.

Both of the belief items were combined to form the belief variable. Results for $H1_B$ indicates that beliefs (Table 4.8) significantly impact contractors overall evaluation, with a $F_{(1, 378)} = 320.03$, $p < 0.01$, and a r^2 of 0.458. The finding lends support that underlying beliefs do affect a contractors overall evaluations toward the recovery of spent CCA treated lumber.

Table 4.8. Regression Analysis of Hypothesis 1_B – Beliefs on Evaluation[1].

Item	Unstandardized Beta	Beta	t-statistic	p-value
constant	0.715		13.745	< 0.01
Beliefs	0.664	0.677	17.889	< 0.01

1. Dependent Variable – Overall Evaluation.

Hypothesis Two

The second hypothesis posited that subjective norms would not influence the contractor decision intention to begin recovery. For this analysis, the subjective norm independent variable was the combination of the two subjective norm items. Evidence for rejecting this hypothesis was discerned in regression analysis, with a t-statistic of 9.330, a $F_{(1, 378)} = 87.05$, and $p < 0.01$ (Table 4.9). The result of the analysis indicates that subjective norms appear to affect the contractors' decision intention; therefore the hypothesis that normative beliefs do not have an affect on the decision intention was rejected.

Table 4.9. Regression Analysis of Hypothesis Two – Subjective Norms on Decision Intention[1].

Item	Unstandardized Beta	Beta	t-statistic	p-value
constant	-0.323		-2.469	0.014
Subjective Norms	0.607	0.433	9.330	< 0.01

1. Dependent Variable – Decision Intention.

Hypothesis Three

Hypothesis 3_A posits that the contractors' decision intention and attitude toward recovery will be moderated by perceived behavioral internal control. For this analysis, the evaluation and belief items were combined to form the attitude toward recovery, and the interaction variable was the internal control variable multiplied by the attitude toward recovery. This formed the proposed attitude toward recovery (ATR)-internal control variable.

Results included an r^2 of 0.085, a significance of $F_{(2, 377)} = 18.60$, and $p < 0.01$. There was no evidence ($p = 0.685$), (Table 4.10) of an interaction effect. Therefore the statistical evidence does not support contractor's decision intention being moderated by an interaction between ATR and internal control.

Table 4.10. Regression Analysis of Hypothesis 3_A – Attitude toward Recovery - Internal Control Effects on Decision Intention[1].

Item	**Unstandardized Beta**	**Beta**	**t-statistic**	**p-value**
constant	-1.207		-10.685	< 0.01
Attitude toward recovery (ATR)	-0.136	-0.232	-1.353	0.177
ATR x IC	-0.010	0.070	0.406	0.685

1. Dependent Variable – Decision Intention.

Hypothesis 3_B posits that the contractors' decision intention and attitude toward recovery will be moderated by perceived external control. As with the internal control, the combined evaluation and belief items formed the attitude toward recovery variable. Combining the external control items formed the external control variable, and the external control variable multiplied by the ATR variable formed the proposed attitude toward recovery-external control variable.

Results from the regression analysis indicated that each variable had a significant impact on contractors' decision intention, including the ATR-external control variable (Table 4.11). Results from regression analysis included a r^2 of 0.190, with a significance of $F_{(2, 377)} = 45.45$, and $p < 0.01$. The proposed moderator variable was very significant ($t > 7.00$, $p < 0.01$); therefore there is strong support that contractors' decision intention is moderated by an interaction between ATR and perceived internal control. Ajzen (1991) posited that an interaction between intention and components of perceived behavioral control could occur.

Table 4.11. Regression Analysis of Hypothesis 3_B – ATR-External Control Effects on Decision Intention[1].

Item	Unstandardized Beta	Beta	t-statistic	p-value
constant	-1.109		-12.158	< 0.01
ATR	0.162	0.275	2.926	0.004
ATR x EC	0.092	0.659	7.005	< 0.01

1. Dependent Variable – Decision Intention.

Additionally, a contingency table of responses and a plot of the response frequency illustrate the interaction (Table 4.12, Figure 4.4).

Table 4.12. Contingency Table (2 x 2) of Responses to External Control and Evaluation Items.

Scale	External Control	Evaluation
-3	180	6
3	3	86

As illustrated in Figure 4.4, negative external control ratings correspond to negative evaluations of recovery. Conversely, as the external control ratings increase (i.e., positive ratings), so do the evaluations for the recovery of used CCA lumber. It can be surmised that external control (centers available and programs) are facilitators for the recovery of used CCA treated lumber. Contractors' intention to recover used CCA treated lumber is moderated by the fact that there are no existing facilities or recovery programs in place. Again, this lends support to the establishment of recycling programs and the building of recycling facilities.

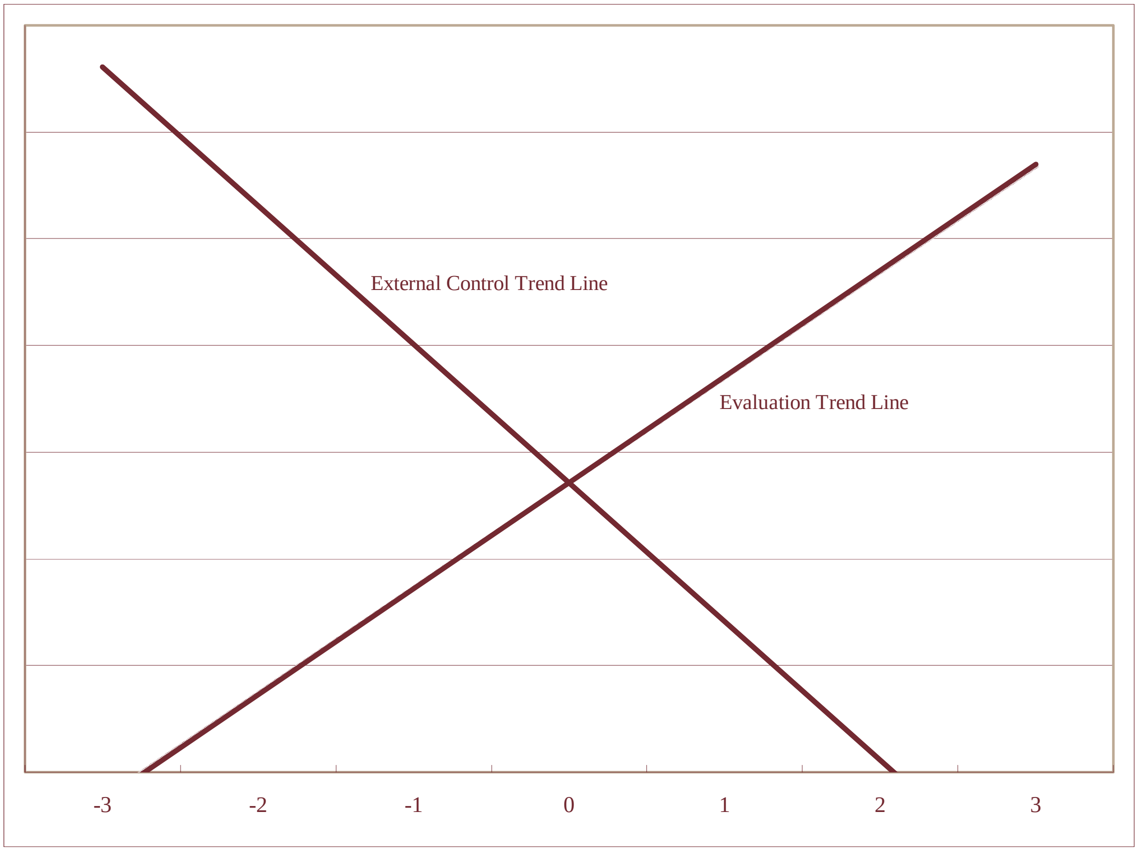

Figure 4.4. Plot of the Interaction Effect of Evaluation and External Control.

Hypothesis Four

Hypothesis four posits that the awareness construct will affect the contractors' decision intention concerning recovery of used CCA lumber. Both factor and correlation analysis results for the health risk item were insignificant. The perceived risk item was dropped from the analysis, leaving a single item for awareness (knowledge). For this analysis contractors' decision intention and awareness were utilized.

Results of the regression analysis indicated that awareness had a significant impact on the contractor decision intention (Table 4.13). The results included an r^2 of 0.215, a significance of $F_{(1, 378)} = 104.81$, and $p < 0.01$. The proposed awareness construct was significant ($p < 0.01$); therefore there is support that awareness influences the decision intention.

Table 4.13. Regression Analysis of Hypothesis Four – Awareness on Decision Intention[1].

Item	Unstandardized β	β	t-statistic	p-value
constant	-0.499		-4.516	< 0.01
Awareness	0.517	0.466	10.238	< 0.01

1. Dependent Variable – Decision Intention.

In summary, the majority of the hypotheses examined received support. It appears from this analysis that evaluations and beliefs, subjective norms, knowledge, and the perceived behavioral control constructs are a reasonable mechanism for understanding the contractors' decision intention. The next section will discuss the model analysis.

Model Analysis

To analyze the theoretical model (Figure 4.1), both hierarchal regression and structural equation modeling were utilized. Presented first will be the analysis from the hierarchal regression. In this analysis, each independent variable was added sequentially.

Hierarchal Regression Analysis

Seven separate models were run, and the final adjusted squared multiple correlation (R^2) indicates that over 49 percent of the variance was explained. The final model included the evaluation, belief, subjective norm, awareness, internal and external control, and the evaluation-external control interaction variables (Table 4.14).

Regression analysis indicates that evaluation is not a significant predictor of decision intention. Based on the magnitude of t-statistic scores, external control and beliefs are the constructs that impact contractors' decision intention most. Subjective norms and internal control follow, and also have a decreased impact on the decision intention. Finally, the evaluation-external control interaction variable also assists in predicting the contractors' decision intention (Table 4.14).

Table 4.14. Final Hierarchal Regression Analysis for Contractors' Decision Intention[1].

Item	Unstandardized Beta	Standard Error	Standardized Beta	t-statistic	p-value
constant	0.529	0.230		2.295	0.022
Evaluation	-0.014	0.091	-0.011	-0.159	0.874
Beliefs	0.394	0.080	0.304	4.916	< 0.01
Subjective Norms	0.213	0.058	0.152	3.650	< 0.01
Awareness	0.120	0.050	0.109	2.390	0.017
Internal Control	0.164	0.054	0.113	3.038	0.003
External Control	0.248	0.045	0.243	5.548	< 0.01
Evaluation by EC	-0.069	0.021	-0.176	-3.300	< 0.01

1. Dependent Variable – Decision Intention.

The non-significance of evaluation in the final model may be due to both multi-colinearity, and to the moderating effect of the evaluation – external control variable. The percentage of variance explained increased from an initial R^2 of 0.27 to a final adjusted R^2 of 0.49 (Table 4.15).

Upon closer inspection, certain changes in variance explained do not appear, on a cursory level, to be a statistically significant change in the overall variance explained. Using an equation presented by Jaccard *et al*. (1990), each incremental change in R^2 was analyzed. The analysis indicates that Model three (the addition of subjective norms) accounted for a 0.013 change in R^2 and this was not statistically significant. Additionally, Model four (the addition of awareness), Model five (the addition of internal control), and Model six (the addition of external control), were also found not to be a statistically significant change in variance explained. And finally, the additional variance explained by the evaluation-external control variable was analyzed, and the change in variance explained (0.015) was also found not to be significant (Table 4.15).

Table 4.15. Analysis of Incremental Explained Variance.

Models & Number	**R^2**	**R^2 Change**	**Adjusted R^2**	**F-Change**	**Significant F-Change**
1	0.277		0.275	144.99	$p < 0.01$
2	0.383	0.106	0.380	117.01	$p < 0.01$
3	0.419	0.036	0.414	90.39	$p > 0.05$
4	0.432	0.013	0.426	71.38	$p > 0.05$
5	0.450	0.018	0.442	61.09	$p > 0.05$
6	0.481	0.031	0.472	57.57	$p > 0.05$
7	0.496	0.015	0.486	52.22	$p > 0.05$

All of these constructs appear to be viable mechanisms for explaining the contractors' decision intention, however three of the constructs did not explain a significant percentage of the variance. It could be argued those constructs could be dropped as a result of non-significant changes in variance explained. However, given the relationship of theses constructs to the theory, the responses of the participants, and the significance of the evaluation-external control interaction variable, these constructs were retained in the final regression analysis model.

Next, the model will be presented as analyzed with structural equation modeling.

Structural Equation Modeling Analysis

To test construct relationships in a simultaneous manner, path analysis using Amos 4® was performed, with raw data as the input. The awareness and subjective norm constructs were dropped from the model analysis; evidence for supporting the non-inclusion of these constructs was provided by factor analysis (neither construct loaded in a sufficient manner), and the results from hierarchal regression indicated that the awareness construct explained an insignificant portion of the variance.

A path model was estimated utilizing evaluations and beliefs, internal control, and external control constructs. The model was first estimated by evaluating an initial or exploratory model to assess the constructs. Nine observed endogenous variables were the predictors for the 13 unobserved exogenous variables, and the contractors' decision intention recovery intention was also an observed endogenous variable. Paths were drawn from each of the predictor variables to the observed endogenous variable - contractors' decision intention (Figure 4.5.)

In the exploratory model the constructs and error terms are assumed to be uncorrelated. In order to modify the model to achieve a better fit, certain assumptions were relaxed. The assumptions were relaxed by allowing the evaluation and belief constructs to become correlated; also belief and internal control, internal control and external control, recovery and beneficial beliefs, and the time and programs in place error terms were allowed to correlate.

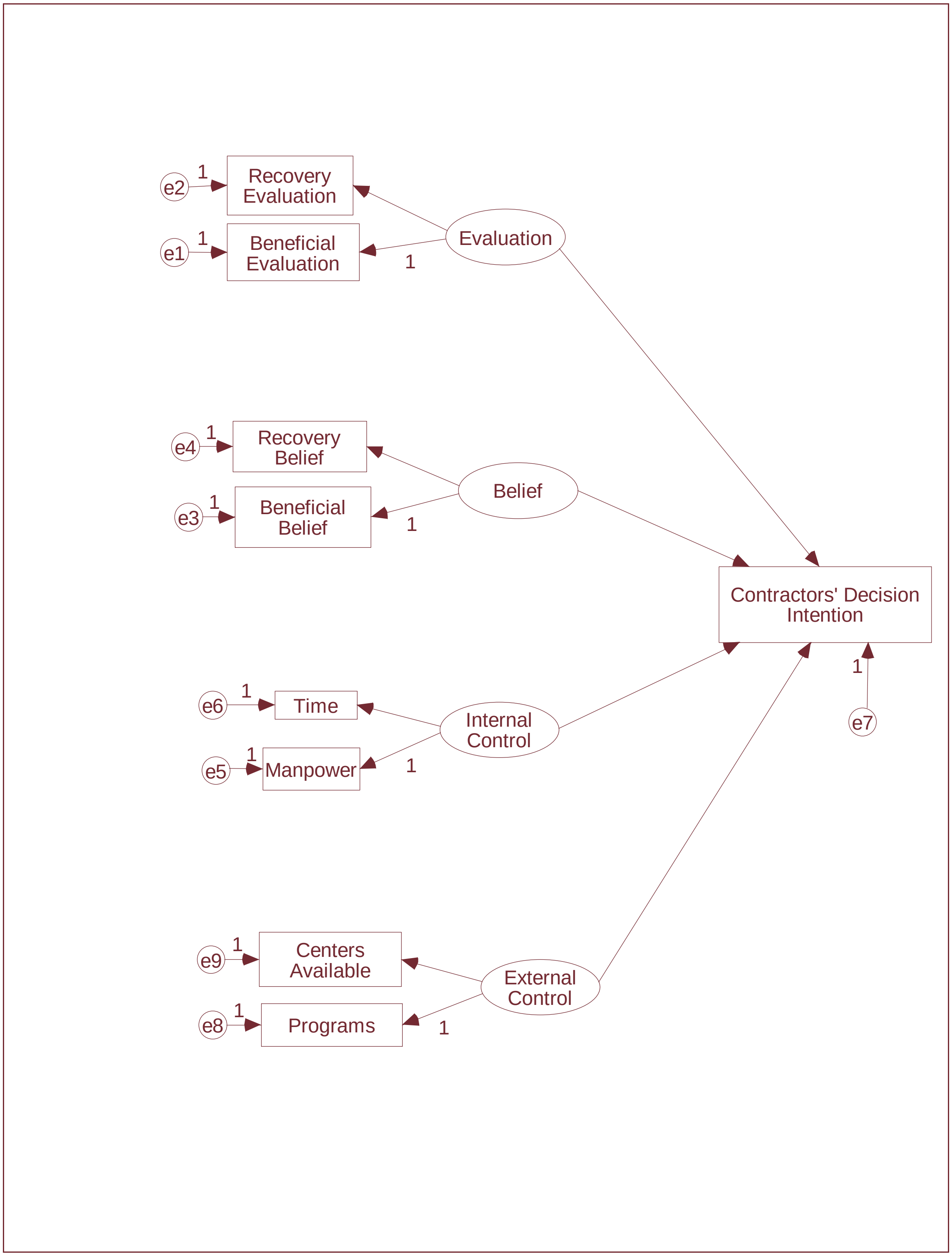

Figure 4.5. Exploratory Model of Contractors' Decision Intention to recover.

These correlations must have theoretical foundations as well. As an example, consider the evaluations and belief constructs; it is reasonable to assume that a contractor's evaluation would be affected by their beliefs (and in the theory of planned behavior, it is posited that beliefs drive evaluations.)

The model was initially estimated by evaluating the full model to assess model fit. Next, as mentioned previously, certain constructs were allowed to correlate in order to achieve a better model fit. Finally, certain error terms were allowed to correlate. The results of the analysis follow below.

The initial model resulted in a χ^2 of 429.79, degrees of freedom (df) = 25, and a significant p-value ($p < 0.01$). This is defined as the chi-square fit index (Jaccard & Wan, 1996), and the initial results indicate that the model did not achieve a good fit.

For confirmatory analysis, the evaluation and belief constructs were allowed to correlate. This resulted in a χ^2 of 124.70, df = 24, and a significant p-value ($p < 0.01$). Third, a correlation between beliefs and internal control was executed. This resulted in a χ^2 of 88.40, df = 22, and a significant p-value ($p < 0.01$). Next, the error terms between beneficial evaluations and beliefs were allowed to correlate, resulting in a χ^2 of 24.80, df = 21, and a non-significant p-value ($p > 0.25$). The result from step four indicates that the model fits the data reasonably well and was acceptable. In order to achieve a better model fit, the error terms for manpower and centers available were allowed to correlate. This resulted in a χ^2 of 17.64, df = 20, and a non-significant p-value ($p = 0.611$). The final result indicates that the model does fit the data reasonably well.

Other fit measures have been developed and are calculated by AMOS to indicate whether a model has achieved proper fit. Included are the goodness-of-fit-index (GFI) and adjusted goodness-of-fit-index (AGFI). The scores for these indices can range from zero to one. A model with good fit should be greater than 0.90 (Tinsley & Brown, 2000). Results of the analysis included a GFI score of $p = 0.99$, and an AGFI of $p > 0.97$.

Two other fit indices typically are reported as well, the standardized root mean square residual (RMR) and root mean square error of approximation (RMSEA). RMR scores should be ≤ 0.05 (Kline, 1999) and RMSEA scores should be ≤ 0.06 (Hu & Bentler, 1995). The analysis resulted included RMR ($p = 0.05$) and RMSEA ($p < 0.01$). The aforementioned test results indicate that a close fit was achieved for the model. In addition, the RMSEA-PCLOSE value for testing model fit was 0.991; also indicating that a close fit was achieved.

Common fit measures are also produced, and include the comparative fit index (CFI), incremental fit index (IFI), normed fit index (NFI), and the Tucker-Lewis index (TLI). Each of these procedures compares the study model to a baseline model that is generated by the program. The scores for these indices range from zero to one, and scores less than 0.90 are considered unacceptable (Tinsley & Brown, 2000). Analysis of the final model (Figure 4.6) resulted in a CFI score of $p = 1.00$, IFI ($p = 1.00$), NFI ($p > 0.99$), and TLI ($p = 1.00$). All of the aforementioned indices indicate that an acceptable model fit was achieved.

Path Analysis

From the analysis, evaluations were not a significant predictor of the contractors' decision intention to recover spent CCA lumber ($p > 0.58$, $\beta = 0.050$), (Table 4.16). The path from beliefs to decision attention was the strongest indicator, with a standardized beta coefficient of over 0.52 and a $p < 0.01$. This finding is similar to that found in the regression analysis, as beliefs were a significant predictor of the decision intention. This adds additional support that beliefs are a critical component in the theory of planned behavior, and lends further credence to the development of a positive marketing communications campaign to be directed to the contractors.

Table 4.16. Path Analysis of Contractors' Decision Intention.

Path	**Unstandardized Beta**	**Standard Error**	**Standardized Beta**	**p-value**
Evaluations → DI[1]	0.070	0.128	0.050	0.58
Beliefs → DI	0.770	0.151	0.521	< 0.01
Internal control → DI	0.215	0.053	0.203	< 0.01
External control → DI	0.295	0.076	0.155	< 0.01
Beneficial evaluation → Evaluation	1.000		0.880	
Recovery evaluation → Evaluation	0.998	0.050	0.898	< 0.01
Beneficial belief → Belief	1.000		0.836	
Recovery belief → Belief	1.119	0.058	0.886	< 0.01
Time → Internal control	0.976	0.062	0.925	< 0.01
Manpower → Internal control	1.000		0.888	
Programs → External control	1.000		0.681	
Centers Available → External control	1.576	0.091	0.978	< 0.01
Intention → DI	1.000		0.705	

1. Contractors' Decision Intention.

The internal control construct was also very significant ($p < 0.01$, $\beta > 0.20$), and the standardized beta value was higher than discerned in regression analysis. The analysis for external control yielded a standardized beta over 0.15, and the path was significant ($p < 0.01$), (Table 4.16, Figure 4.6). While the findings regarding the magnitude of the perceived behavioral control components were unexpected, the results do lend support to for recovery programs and convenient facilities being established. The next paragraphs will discuss the correlations and covariances discerned between the constructs.

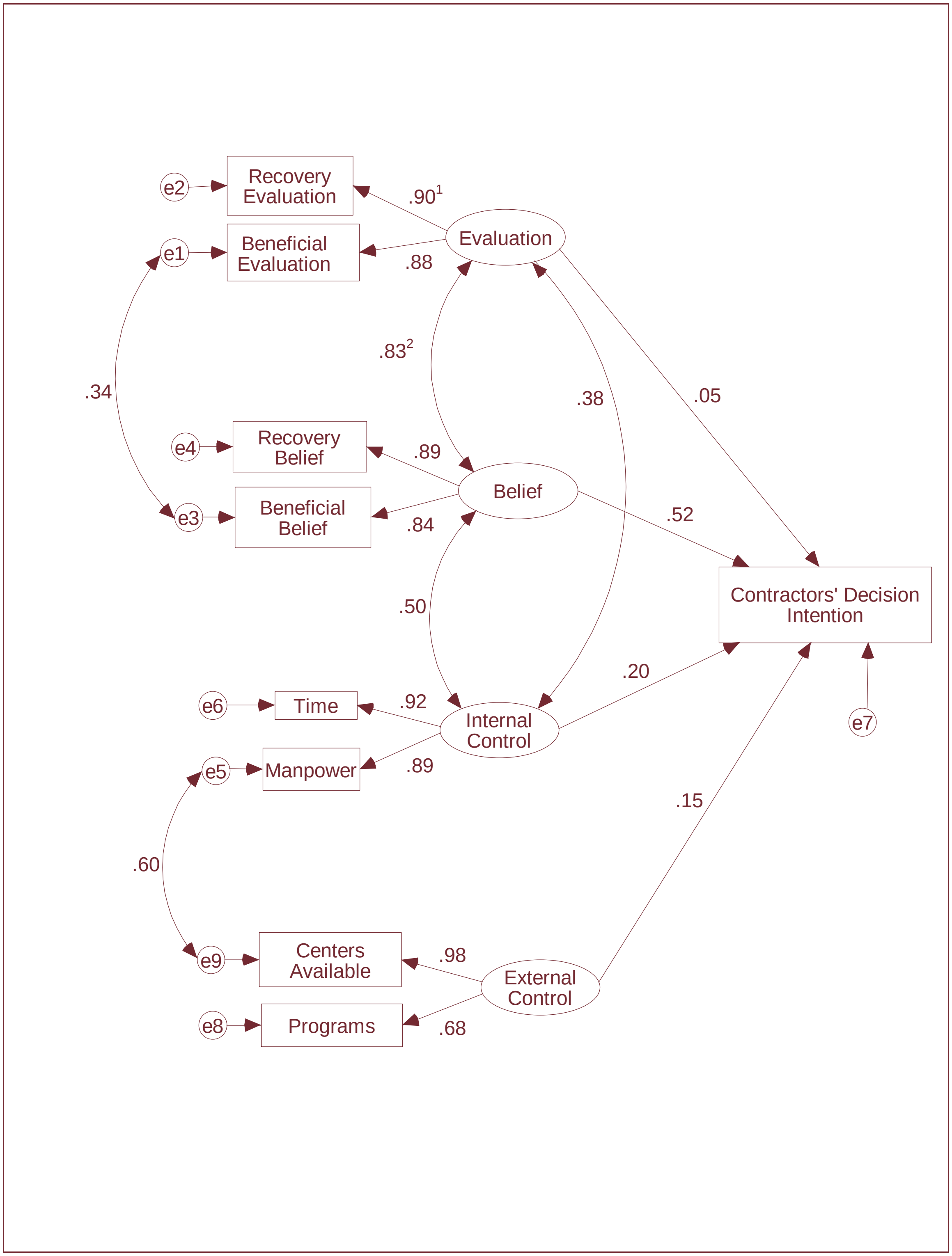

Figure 4.6. Final Path Model of Contractors' Decision Intention.
1. Standardized regression weights.
2. Correlation.

The analysis also yielded covariances and correlations among the unobserved constructs. First, the covariance and correlation between evaluations and beliefs are relatively high (1.26, r = 0.83, respectively). The affect of beliefs on the decision intention was similar to those found in the regression analysis and the belief construct appears to be mediating evaluations. This finding should be expected as both constructs are combined to form the attitude toward the recovery of spent CCA treated lumber. The covariance between beliefs and internal control was also strong (1.02) and the correlation was also high (r = 0.50). The correlation between evaluations and internal control was moderate, and the covariance was low as well (Table 4.17, Figure 4.6.)

Table 4.17. Covariance and Correlations Among Constructs and Error Terms.

Path	Covariance	Standard Error	r	p-value
Evaluation ↔ Beliefs	1.259	0.130	0.828	< 0.01
Beliefs ↔ Internal control	1.016	0.138	0.505	< 0.01
Evaluation ↔ Internal control	0.809	0.134	0.381	< 0.01
Beneficial evaluation error ↔ Beneficial belief error	0.184	0.046	0.342	< 0.01
Manpower error ↔ Centers available error	0.164	0.062	0.599	0.008

Also of note was the covariance between the beneficial evaluation and the recovery belief error terms. The correlation and covariance between the error terms may represent variability in the beneficial errors that is not due to the variation in the evaluation and belief constructs. Both the beneficial belief and evaluations were scale scores in the instrument. This may indicate that the variables share a common variance between the two constructs that is not being accounted for by either item and the items are sharing the variance. This may indicate there is another item that could account for the variance and this unknown variable could account for a significant amount of the variance from the participant responses. The covariance was positive at 0.18, and both items were moderately correlated (r > 0.34.) The other correlation was between manpower and centers available. Here the shared covariance was (0.16), and also resulted in a moderate correlation (0.59.) Again, this may indicate that the two items measure a commonality that is not represented in the model (Table 4.16).

Research Summary

The study findings appear to provide strong support for the majority of the hypotheses and the proposed intention model as a viable method for examining the effects of evaluation, beliefs, subjective norms, awareness, and internal and external control on the contractors' decision intention to recover spent CCA treated lumber.

Both regression and structural equation modeling were used to examine the decision intention, and consistent results were obtained with both methods. Regarding evaluations, results from both of the analysis methods indicated that evaluation did not have a similar impact on intention as beliefs. Nevertheless, the analysis indicated that evaluation plays a vital role in the examination of contractors' decision intention. And when evaluation is combined with beliefs, both of the constructs are viable mechanisms for examining the contractors' decision intention.

In both analyses the strength of beliefs was very significant. This not only supports beliefs role in the theory of planned behavior, the findings also indicate contractors appear to have a positive (low) belief concerning recovery, if the recovery centers and programs were made available. This is not only evidenced by the strong correlations between recovery belief and intention, but also with the beneficial and recovery evaluations. Secondly, regarding the contractors' beneficial belief, the recovery of CCA lumber appears to be regarded as a beneficial act. Analysis also indicated that the beneficial belief corresponds strongly with the same items as the recovery belief.

When reviewing the impact of beliefs on evaluations and intention, it is clear that beliefs appear to be a significant driver of the contractors' decision intention. The implication being that recovery centers and programs should be considered to facilitate recovery. In addition, this also supports a focused promotional message being developed and implemented concurrently with the establishment of recovery centers and programs.

Concerning the perceived behavioral control construct, both internal and external control played a significant role in explaining the factors involved in a contractors' decision intention. It could be argued that internal control is economic in nature, apparently reflecting the need for both financial incentives and recovery programs being developed. The impact of external control appears to indicate that the requisite facilities are currently not in place for recovery, and must be developed. Additionally, there was a significant interaction between evaluation and external control, indicating that contractors "perceive" that they do not have volitional control over recovery.

In regards to subjective norms, this construct is a reasonable mechanism for explaining the contractors' decision intention. On further investigation, the "guilty" item played a significant role in the findings than the social norm item. "I would feel guilty if recovery centers were available and I did not recover used CCA lumber," correlated strongly with both of the belief items. This lends support to the need for a promotional message, and for the establishment of recovery centers and programs, as it appears that contractors would feel guilty if they did not recover. While subjective norms were statistically significant, the quantity of variance explaining was marginal as compared to beliefs and evaluations. There appears to be just cause for the addition of awareness, the quantity of variance explained limits its effectiveness as a construct. The findings regarding subjective norms are similar to those found by Chamberlain (2000) and Bagozzi and Dabholkar (1994). In these studies subjective norms were significant, but the construct did not explain an appreciable amount of variance.

While the awareness construct was significant, the variance explained was not statistically significant. However, it was and is a construct worth investigating, as several contractors inquired about the necessity of recovering used CCA treated lumber. This finding also lends support for the development of a promotional message that addresses the need for recovery. As alluded to earlier, the promotional message will have to be focused, and implemented concurrently with the development of recovery programs and centers.

Conclusion

In this study the contractors' decision intention towards the recovery of spent CCA treated lumber was examined. In particular, we examined the incremental explanatory power of the evaluations and beliefs toward recovery, subjective norms, a knowledge component, and perceived behavioral control.

Both the results of OLS regression and structural equation analysis demonstrated support of the affect beliefs have on evaluations, and subsequently on the contractors' decision intention to recover spent CCA lumber. The findings indicate that beliefs play a more significant role than evaluations. An interaction between evaluations and perceived external control was discerned, just as Ajzen (1991) had posited. The results indicate that “perceived” barriers to recovery exist, and must be addressed before any substantial recovery will occur.

The public policy and managerial implications from this study are many. First, both recovery facilities and programs will have to be established. From this researcher's perspective, the preservative treating and wood products industries should be the leaders in this arena. Both industries could establish substantial goodwill and develop strong public relations with both the contractors and consumers. However, if the federal or state governments are relied upon to initiate the programs and facilities, the goodwill that could have been established is probably lost. Additionally, if government officials become involved, the associated costs and regulations may be increased as well. Also lost is the opportunity for a truly positive marketing communications campaign concerning the recovery of used CCA treated lumber.

Secondly, with the establishment of recovery programs and facilities, a marketing communications campaign promoting all facets of recovery and recycling must be developed. This study highlights the importance of designing a marketing communications campaign that positively shapes contractor evaluations and beliefs. If advertising is a component of the campaign, it appears that recovery would be most effective if local contractors were utilized in the ads. In this manner, area contractors could possibly relate more strongly to the message being promoted.

Third, the treating industry, the wood products industry, and university researchers need to develop a viable line of new products or processes for the conversion of recovered treated lumber. The initiation of the recovery process is only the first step in the recycling process.

Finally, results of this study indicate the contractors appear have a moderate belief that recovery of used CCA treated lumber is a "good thing." Therefore, it is now time for the wood products and treating industries to get the proverbial "ball rolling," by becoming an active leader and sponsor for the recovery of used CCA treated lumber.

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CHAPTER FIVE. Government And Industry Perspectives Concerning The Use And Disposal Of CCA Treated Lumber

Introduction

Recent research concerning preservative treated lumber taken out of service indicates there is an urgent need to determine the factors affecting the recovery, recycling, and the utilization of used CCA treated lumber. However, there is a fundamental lack of knowledge concerning the factors associated with the removal and potential recovery of CCA treated lumber.

This study focused on the removal of CCA treated Southern yellow pine products utilized in decking applications. Southern yellow pine is the primary species group that is preservatively treated in the United States. Production is estimated to average nearly six billion board feet a year during the time frame 1997 to 2004 (Southern Forest Products Association (SFPA), 2000). The SFPA also estimates that over two billion board feet were utilized in the fabrication of decking in 2000. Treated Southern yellow pine is also used in many other applications, which includes framing, trusses, wood foundations, agriculture, industrial uses (e.g., marine, highway, and material handling), fences, landscaping, remodeling, and products for export. It should be noted that the largest share of treated lumber is estimated to be utilized in outdoor decking, nearly 38 percent (SFPA, 2000).

The preservative treating of wood, particularly Southern yellow pine, exhibited dramatic growth in the early to mid-1970's. The treating of wood products extends the life of these products and at the same time protects against bacteria, insect, and fungal attacks. CCA, a water borne preservative, is the primary preservative treatment chemical used for treating wood products.

There is also growing concern over both the disposal of spent CCA treated lumber and treated lumber *in situ* applications. Recent and ongoing work in the State of Florida has revolved around the leaching of treatment chemicals into the soil and alternative methods of disposal for used CCA treated lumber. An alternative to the disposal of used lumber directed to landfills is the recovery of and subsequent recycling of spent lumber.

A plethora of factors are not understood or known about the potential recovery of spent CCA treated lumber. These factors include deck sizes, age of the treated lumber at removal, deck removal factors, lumber disposal practices, and barriers toward the recovery and recycling of used lumber. These factors must be investigated in order to affect the recovery and recycling of CCA treated lumber. Working with the knowledge gained from contractors will assist in developing recovery promotional messages directed to contractors and the homeowner (to facilitate recovery), the establishment of recycling and recovery programs, and recovery and recycling facilities.

Case studies were conducted with state waste management officials, landfill managers, building inspectors, and contractors. The purpose of the interviews was to gain an in-depth understanding of the factors regarding CCA lumber use in decking applications, disposal, recovery/recycling, current government policies, barriers and incentives, and gather general opinions concerning the recovery of spent CCA lumber. Another facet of the interviews was to determine if any recovery/recycling centers or programs were available for used CCA lumber.

Case studies were conducted with waste management officials and building inspectors from Charlotte, North Carolina (NC), Greenville, South Carolina (SC), and Decatur, Georgia (GA). Contractors were also interviewed in greater Atlanta, Georgia;

North Carolina; and Greenville, SC. Landfill managers from Charlotte, NC, Greenville, SC, and Chamblee, GA were also interviewed.

Qualitative Research

The results presented in this chapter are primarily qualitative in nature. Qualitative research allows for selected issues to be studied in-depth, and Yin (1989) stated that a distinguishing feature of case studies is that they examine existing phenomenon in a real-life context.

An interview schedule was employed, with identical questions being asked of each interviewee type. A systematic interview schedule was utilized in order to avoid becoming too influenced by the participants, and to avoid revealing researcher prejudices (Eisenhardt, 1989). The results are presented by interviewee type, and may also include direct quotes from the participants.

Objectives

1. Identify critical factors that influence the recovery and recycling of used CCA treated lumber.

2. Discern government officials and contractors perceptions of the recovery and recycling of used CCA treated lumber.

Data Collection

The populations of interest were state and local waste management officials, landfill managers, building inspectors, and contractors in GA, NC, and SC. These groups were of interest as a result of their position, certain factors regarding recovery that could not be accessed from the mail questionnaire, and it allowed contractors to speak freely without the constraints of the mail questionnaire format. Contractors were randomly selected and the other participants were selected as a result of their location or government position. The geographic region was of interest because it was believed that these cities and states are representative of CCA lumber use and disposal in the Southeast.

Interviews were pre-arranged with the participants and typically lasted less than one hour. Each interview opened with an explanation of the research project, then a semi-structured interview was conducted, with several open-ended questions being asked of the interviewee. The questionnaires (Appendix D) were reviewed and approved after consultation with scholars at Virginia Tech and by personnel from the U.S. Forest Service Southeastern Research Station. A total of 18 individuals participated in the study and typically qualitative interview studies include 15 ± 10 interviews (Kvale, 1996).

Data Analysis

Analysis of the data began by examining the transcripts from the interviews and categorizing the responses by interviewee type (Table 5.1). Key quotes from selected participants will also be presented.

Table 5.1. Case Study Participants by Category.

Category	Number
State waste management officials	3
Local waste recycling officials and landfill managers	4
Building inspectors	3
Contractors	8

State Waste Management Officials

Waste management officials were interviewed to gain insight into their respective states current policies toward CCA lumber, disposal practices, and to ascertain if any programs were being considered for the recovery and recycling of CCA lumber. Participants included a member from Pollution and Environmental Assistance in North Carolina, a member from the Center of Waste Minimization in South Carolina, and a member of the Solid Waste Management program in Georgia.

Georgia – The first question concerned the State of Georgia's current policy towards the disposal of CCA lumber, and it was indicated that there was not an effort in Georgia to restrict the disposal of CCA lumber. Second, was an inquiry on the quantities of CCA lumber directed to GA landfills, and the interviewee indicated used CCA lumber was a small part of Georgia's waste stream. Finally, the participant was asked if they were aware of any recovery and recycling efforts in the Southeast or the United States. The participant was aware of the CCA project in Florida, and was keeping abreast of that particular research. The interviewee also indicated that Florida probably consumed more treated lumber than Georgia. Additionally, the interviewee felt that Georgia does a good job in disposing of C&D wastes. The Georgia Environmental Protection Agency provides an extensive website that includes directories and fact pages.

Key Quote: *"We feel that Georgia does not have a problem with CCA lumber disposal and we do not have any plans to restrict it from the waste stream."*

North Carolina – North Carolina currently does not have any restrictions regarding the disposal of spent CCA lumber. However, the participant expressed deep concern over the leaching of heavy metals from CCA lumber, current CCA lumber use and applications, and CCA lumber disposed in landfills. The interviewee mentioned that lined landfills leak and chemicals leaching from other materials, combined with leached CCA metals, have the potential to create a more severe problem. During this session the participant indicated being in favor of banning CCA lumber from use in North Carolina. Regarding CCA lumber, the participant stated that North Carolina would favor used CCA lumber being disposed of in lined landfills; and that North Carolina would continue to follow the U.S. Environmental Protection Agency (EPA) guidelines. The interviewee was aware of the CCA project in Florida and actively kept abreast of that program's development(s). The interviewee did not have an estimate of the quantities of CCA lumber reaching NC's landfills.

The participant stated that North Carolina had instituted a program for wooden pallets in North Carolina, which includes an emphasis on diverting pallets from landfills, and making pallets available for recovery and recycling. The development of a similar program was mentioned as being a potential option for used CCA lumber.

The interviewee also mentioned a recent development in Wake County, North Carolina; where the NC Department of Environment and Natural Resources assisted in developing a grant to establish a C&D facility specifically for recovering C&D wastes. Reclamation, LLC, is a quasi government and private consortium facility. The facility opened in 2001 and currently handles 300 tons per day of C&D wastes, with the capability to handle 800 tons per day. The material is off loaded, sorted, and the materials are made available for recovery and resale. The C&D materials included wood products, metals, gypsum, plastic, dirt fines, and other residuals.

Key Quote: *"I would be in favor of banning CCA lumber from use in North Carolina."*

South Carolina – The participant was unaware of any problems associated with the disposal of CCA lumber and did not consider it to be a hazardous waste. Regarding the quantities of CCA lumber being directed to South Carolina facilities, it was stated that spent CCA lumber was not a major constituent of South Carolina's waste stream. The interviewee stated that lead paint based materials were segregated in the waste stream, and that South Carolina's disposal guidelines were equivalent to U.S. EPA regulations. The participant was aware of the pallet work in NC, but was not aware of any other programs in the Southeast or the United States regarding CCA lumber.

The interviewee then asked, "What are the options for the recovery of used CCA lumber?" After listing some of the options, a comment was made regarding the chemical processing of spent CCA lumber, particularly in Germany. "That (chemical processing) is a very expensive operation, the infrastructure is not in place to start chemical processing at this time. The Germans probably have developed markets for the processed materials as well."

Key Quote: *"As long as a material is not hazardous, it is legal to dispose of the material in South Carolina landfills."*

Waste Recycling Officials and Landfill Managers

The Waste Recycling Director for Mecklenburg County, North Carolina stated that they did not have any current plans for the separation of CCA lumber. The interviewee stated, "They (recyclers) do not know what to do with recovered CCA material." The interviewee was writing a proposal to acquire the funds to establish a C&D sorting facility. The Mecklenburg facility would be modeled after the facility in Wake County, NC.

The Charlotte/Mecklenburg County Waste Management Division provides extensive support for recovery and recycling. It includes several recovery/recycling fact sheets that detail financial information regarding recovery, how to set up recovery on site, recovery and disposal options, and a list of private and government drop-off and recovery facilities. They also provide an extensive website devoted to disposal, recovery, and recycling options in the county. Of the sites visited, Charlotte/Mecklenburg provided the most useful information and appear to be situating themselves to become a leader in recovery and recycling.

Key Quote: *"They (recyclers) do not know what to do with recovered CCA material."*

Charlotte/Mecklenburg, North Carolina

Mecklenburg County operates four C&D landfill facilities, with the newest facility located south of Charlotte (Foxtrot Landfill). The landfill manager was asked several questions and the responses follow. This facility did not separate CCA lumber from other debris; the primary method of disposal was burial with soil compaction along with other wastes. CCA lumber was not considered a hazardous material and the manager could not quantify or speculate on the amounts of used CCA lumber directed to this facility. When asked what types of incentives could be instituted to facilitate the recovery of CCA lumber, the response was "… some type of government program that includes tax incentives." In addition, the manager had not received or was aware of any information concerning CCA lumber recovery.

Greenville County, South Carolina

The Greenville County facility was a government operated landfill; however there are private C&D facilities located in the county as well. The Greenville County facility did not separate CCA lumber and burial/compaction was the disposal method. CCA lumber was not considered to be a contaminated material and there were no plans to begin the recovery of CCA lumber. The quantities of CCA lumber directed to this facility were considered to be minimal. The manager was of the opinion that a large percentage of spent CCA lumber was directed to private facilities, as private C&D facilities charge tipping fees that are $6 to 10 per ton less than the government facility. The manager responded that some type of government sponsored program should be instituted to facilitate the recovery/recycling of CCA lumber. Finally, the manager was not aware of any programs regarding the recovery of CCA lumber.

Greenville County also provides fact sheets regarding disposal of wastes and also operates a website for recycling, treated lumber is not one of the recycling priorities.

Greater Atlanta, Georgia

The City of Atlanta contracts C&D disposal to two waste management companies, and four C&D facilities are located in greater Atlanta. The site visited for Atlanta was located in North Chamblee and was a C&D facility. CCA lumber was not separated from other materials and the primary method of disposal was a soil compaction burial. CCA lumber was not considered to be a contaminated material, and there was not a program in place for the recovery of CCA wood. However, the manager mentioned that university and company officials had recently toured the facility. The officials were considering establishing a recovery operation for "clean" wood, but this did not include treated lumber. The manager could not quantify the amount of CCA lumber directed to the facility, but speculated that it would be less than five percent of the total waste volume received. When asked what type of programs could be developed, the participant indicated that some type of government program should be established that included financial incentives for the contractors. The manager had received recovery/recycling material, but the material pertained to clean wood only.

Building Inspectors

Building inspectors were interviewed to gain insight into current building codes regarding CCA lumber, decking materials utilized, deck sizes, homeowner construction, and deck demolition. Participants included inspectors from Charlotte/Mecklenburg, NC, Greenville, SC, and Decatur, GA.

Charlotte, NC

The first question asked of the inspector concerned the average size of decks built in Charlotte/Mecklenburg. The inspector hesitated to answer, but issued a purely speculative guess of a 15 by 20 square foot deck. Next, the inspector speculated that less than 40 percent of the decks were built by the homeowner. The participant did not remember issuing any permits for the demolition of decks.

During the interview, the inspector stated that the majority of decks were built with treated lumber (greater than 90 percent), and the other materials utilized were wood composite decking materials in upper end homes. The building code of Charlotte/Mecklenburg requires that all material exposed to the effects of weathering must be treated, and sill plates are required to be treated as well. It was also mentioned that some permanent wood foundations were built in the county.

The inspector also stated, “There would be an uproar among contractors if CCA lumber were restricted,” as CCA lumber is readily available and relatively inexpensive as compared to other materials. The inspector also offered the following, “If a house is built in this county without a deck, in the vast majority of cases a deck will be added to the home within four to five years.” He then posed the question, “What would be used in place of CCA treated lumber?”

The Charlotte/Mecklenburg Building Permit Division offers several types of literature on construction, and materials concerning the fabrication of decks.

Key Quote: *“What would be used in place of CCA treated lumber?”*

Greenville, SC

The inspector would not offer an opinion on an average deck size, as Greenville City and County is a fairly large area with numerous homes and decks being built. The inspector stated that homeowners build less than five percent of decks and that most decks are fabricated with treated lumber (greater than 98 percent). Wood composite decking is the other type of material used (less than two percent) and this material was installed primarily in upper end homes. Regarding building codes, decks built at ground level must be fabricated with treated materials; however, decks that are 12 inches above the ground do not have to built from treated material. The inspector did not remember issuing a permit specifically for the demolition of a deck. Greenville County also offers a brochure on deck construction.

Key Quote: *"Most decks are built with treated lumber, more than 98 percent."*

Decatur and Dekalb County, GA

The Dekalb inspector did not offer an opinion on the average size of a deck built in Dekalb County, "I have no idea." The participant also indicated that approximately 99 percent of the decks fabricated were built with treated lumber and less than five percent of the decks built were built by the homeowner. The participant did not remember issuing a permit specifically for the demolition of a deck. The building code of Dekalb County requires that all decks and sill plates be constructed with treated material. Dekalb County also offers pamphlets on deck construction, building codes, and structural requirements.

Key Quote: *"Decks must be built with treated lumber or a weatherized product, probably 99 percent are built with treated lumber."*

Contractors

Contractors were interviewed in order to identify critical factors that influence the recovery and recycling of used CCA treated lumber. The contractors were randomly selected and this format allowed contractors to speak freely without the constraints of the mail questionnaire format. In the course of this research, it was discerned that recovery centers and programs do not currently exist for spent CCA lumber. In the interviews, several questions regarding decking and lumber recovery factors were addressed. The results will be presented by the order of the questionnaire format.

Deck Size and Age at Replacement

The participants were asked, "What was the average size of the decks you built in 1999?" And they were also asked the average age of the decks demolished in 1999. The average size of the decks built in 1999 ranged from 200 to 400 square feet, with the average being 251 square feet. The age of the decks at replacement ranged from six to twelve years, with an average age of ten years at removal. These findings are similar to those discerned from analysis of the mail survey.

Potential Lumber Recovery

Interviewees were asked, "What percentage of lumber potentially could be recovered from a deck?" One contractor stated that they actively attempted to recover and reuse as much CCA material as possible, but speculated that probably 50 percent (on average) could be recovered. The potential recovery percentage for used CCA lumber ranged from zero to 60 percent. Comments included “in practice, only the larger boards could be recovered (4” x 4” or greater).” Another contractor stated that most deck lumber was “nearly worthless,” and it was very hard to “mix recovered and remanufactured boards” with new material. Again, these findings are similar to those discerned from analysis of the mail survey.

Percentage of Lumber Recovered

Participants were asked, “When you demolish or dismantle a deck, what percentage do you recover?” Participant responses ranged from zero to 85 percent. The most frequently reported range was five to ten percent. The interviewee who reported the high recovery percentage actively sought to recover as much material as possible. Another participant stated that they typically recovered less than five percent of the material, but in some cases it could be as high as 50 percent. Only one interviewee deconstructed decks as a practice, others stated that the material they recovered was from demolishing the old deck before replacement with a new deck. The potential lumber recovery findings are within the range of the results received from the analysis of the mail survey.

Major Recovery Problems

Interviewees were asked, “What are the major problems associated with dismantling a deck for lumber recovery?” The most difficult aspect of deconstruction reported by the interviewees was the pulling of nails, and the labor costs associated with nail removal. Other problems associated with deck deconstruction were maintaining the structural integrity of the wood due to the lumber cracking and splitting during removal, bad lumber, raised grain found on the deck boards, brittle lumber, and treated lumber gets hard after it dries out and makes it hard to work with and reuse. Another participant stated, "There are no programs or markets for the used material." These responses are also similar to the responses received from the mail survey.

Programs and Incentives

This question asked participants, "What programs or incentives could be established to facilitate the recovery of used CCA lumber?" The overwhelming response concerned the establishment of recovery facilities. Facility types included specifying an area in the local landfill for used CCA lumber; a separate drop-off facility, a facility where contractors could make available the recovered and remanufactured materials or they could purchase recycled materials, or a pick up program. Regarding programs, one participant stated, "Just develop a program" and "Education programs for carpenters, everything doesn't have to go to the dump." Other responses also included the development of incentives such as tax credits for recovery. These findings lend support to the establishment of recovery centers and programs, and are very similar to the responses received from the mail survey.

Key Quotes: *"There are not any incentives to recover and recycle, need a program developed to address financial incentives, buyers, and product outlets."*

"Education programs for carpenters, everything doesn't have to go to the dump."

"If we recover, where do we sell it, and where can we buy remanufactured materials?"

Potential Products

Interviewees were asked to think of products that potentially could be developed from used material or other uses for used material. Regarding potential products, the participants offered several product options and rehabilitation techniques for existing decks. Two interviewees stated that most deck boards could be flipped over and reused. The materials could be used in smaller decks, for steps, pickets, outdoor projects, small home projects, or the material could be given away. Another suggested that used CCA lumber could be used for non-visible support beams or joists. One participant stated that if you did reuse recovered lumber, it was very difficult to mix and match with the new material. And there was also the problem of the material appearance, as the used material alongside the new material was not very appealing.

Key Quote: "Most people want to replace decks because they are graying, all takes is some soap, bleach, water, and sun to revitalize."

Disposal

The next question asked of the participants was, "What is your primary disposal method for used CCA lumber?" The most frequently mentioned disposal method was disposal at a county facility by all of the interviewees; one interviewee indicated that they burned small amounts of material as a disposal method. Another participant stated that the material they took to the dump was less than eight inches in length. Again, the disposal responses received are similar to the results from the mail questionnaire.

Recovery Tips

The final question asked for any "tricks of the trade" that the contractor could offer to those interested in the recovery and recycling of spent CCA lumber. Three of the participants mentioned flipping the boards over for reuse in existing decks or for use in other projects. One response stated that most decks could be restored with a mixture of soap, bleach, water, and the sun. Other tips included sawing off the ends of the boards (where the nails had attached the boards to a stringer), in this way you could turn a 2” x 4” x 16’ into a 2” x 4” x 14’, etc. Another contractor also suggested that the material could be flipped over and used in other deck projects. Sawing the ends off of the recovered boards to produce a neat appearance was another tip put forth. The other interviewees indicated that the majority of used lumber was not worth recovery because of the condition of the lumber and the costs of dismantling. These results were comparable to the findings from the mail survey, with the exception being the recommendation for decks receiving a chemical wash.

Commentary

Some of the interviewees offered comments and questions in addition to the questions asked of them. One interviewee thought that many builders were taking advantage of consumers by suggesting the replacement of their existing deck, when building a new deck was not the only option. One participant asked, “What are the health risks associated with working with CCA lumber?” Another stated, “I’ve never really given a whole lot of thought to recovering material.” Another participant spoke of the new business opportunities that became available as a result of the treating of Southern yellow pine and how it had increased their contracting business.

Key Quotes: “*Many contractors want to sell the customers a bad bill of goods, they try to sell the customer on replacing the entire deck when it could be refurbished.*”

"CCA treated lumber allows us to build decks; before CCA came along we were not able to build many decks. The West coast species were too expensive."

Research Summary

The findings revealed that CCA lumber disposal is a priority in North Carolina, disposal is not considered to be a problem in Georgia, and at the time of the interview, CCA lumber disposal was not considered to be a problem in South Carolina. Two of three officials were aware of the CCA research project ongoing in Florida. The most salient comment from this portion of the research concerned the banning of CCA lumber from use, and should indicate that the wood treating industry adopt a proactive marketing communications campaign to address the concerns of leaching. Concurrently, the treating industry must develop products to address the leaching of metals from CCA treated lumber or formulate a new preservative.

Recyclers apparently do not have options for the CCA lumber that they recover. This suggests that a viable product line must be developed, as well as a distribution system for the products. Landfill managers indicated that the quantity of CCA material received was not a large percentage of the waste stream. All of the facilities visited buried and compacted CCA lumber along with other materials. In addition, recovery sites for CCA lumber did not exist or and were not currently being considered. The facility managers were unaware of any recovery programs for used CCA lumber.

Building codes in all three cities required the use of treated materials for deck fabrication. Building inspectors indicated that CCA treated lumber was the primary material used in deck fabrication. The most salient statement concerned building material options for the contractor if CCA treated lumber were banned. This is an indicator of not only the value of CCA treated lumber to contractors, but also to the markets for treated Southern yellow pine as well. Another substantive finding was most homeowners will have a deck built within four to five years, if a deck was not built at the time of construction.

The contractors interviewed provided interesting insights in regards to the recovery of CCA lumber. The average deck size and age of the deck at replacement are similar to the results discerned in the mail questionnaire. The size of decks being built is increasing and this bodes well for both the producers of Southern yellow pine and for the treating industry.

Concerning the potential recovery and current recovery of CCA deck lumber, most of the participants indicated that up to 50 percent of the material could be recovered. One interviewee stated that in some cases they recovered up to 85 percent of the deck lumber. The major problems associated with the recovery of CCA lumber appears to be the pulling of nails and the labor costs associated with this action. One participant brought up a notable point, "If we recover, where do we sell it, and where can we buy remanufactured materials?" This lends support to the establishment of spent CCA lumber recovery sites within the local landfill as being a viable recovery option. The remanufacturing, remanufactured product line, and the distribution of remanufactured products will also have to be addressed.

All of the contractors indicated that recovery programs were nonexistent and needed to be developed. When these programs are developed, educational programs that address potential health risks, and the "how to" of recovery of lumber and rehabilitation of decks should be considered. Another program idea put forth was the establishment of a facility where contractors could take the material to sell or be remanufactured, and remanufactured products could also be made available to purchase.

Regarding potential products, it appears that flipping deck boards over is a viable option for reusing CCA lumber. However, one participant mentioned that it was difficult to “mix and match” recovered lumber with new deck lumber. Most participants mentioned that recovered CCA lumber could be used to build small decks or for outdoor projects. A more notable suggestion was that a simple soap, bleach, water mixture and subsequent wash could revitalize a deck. The interviewee stated that many deck owners wanted to replace their deck solely for appearance reasons only. While this is an option for deck rehabilitation, a recent article by Taylor *et al.* (2001) indicates that the chemical washing of decks exacerbates the leaching of metals from CCA treated lumber.

Conclusion

The focus of this chapter was to gain insight into CCA lumber use, disposal of CCA lumber in the selected states, and factors that affect the recovery of used CCA lumber. The results obtained from the interviews did provide additional insights into CCA lumber disposal, and factors concerning the recovery of spent CCA lumber.

The disposal of CCA lumber is a priority in one state, and is not considered to be a problem in the other states. The disparity among waste management officials responses lends support to the development of a marketing communications promotional campaign to address the critical issues concerning the need for the recovery and recycling of used CCA material. Not only will the campaign have to address the issues associated with the recovery of spent CCA lumber, it will also have to be directed to state level waste management officials, city/county officials, and towards the contractors.

The contractors mentioned several items that government officials, the treating industry, and university researchers must address. Currently recovery centers and programs are not available to contractors or to the homeowner. The development of recovery programs and centers must be addressed; the findings of this portion of the research echo the results from the mail survey. The programs should address financial incentives, and educational programs for the contractors must also be a priority. The Charlotte and Mecklenburg recovery and recycling literature provides a good model for the development of recovery literature.

The treating industry should become a leader in the establishment of programs, or at the very least form a partnership with government agencies to institute both the incentives and programs. Several industries have developed recycling programs and actively partner with local governments; these industries include plastic, steel, aluminum, wooden pallets, and paper. These particular industries recovery programs could be utilized to develop a model and recovery program for spent CCA treated lumber. The educational programs could include the sponsoring of clinics or seminars. Government agencies could provide the recovery centers; offer financial incentives, and develop pickup programs. However, in this researchers opinion, the treating industry should be the leaders in this effort.

Finally, the results from this portion of the study coincide with the findings from the previous chapters. Again, the most notable finding concerning recovery was the need for the establishment of recovery programs and centers. It should be apparent to the treating industry and government officials that the establishment of these facilities will have to occur before substantive recovery can take place.

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CHAPTER SIX. An Evaluation of the Factors Affecting The Recovery of Used CCA Treated Lumber

Introduction

Background

In the late summer and fall of 2000 a research project was undertaken at Virginia Tech in cooperation with the U.S. Forest Service Southeastern Research Station to investigate the factors affecting the recovery of spent CCA treated lumber from decking applications. The decision-makers who will develop the recovery and recycling programs for used CCA treated lumber will have available the information to develop the appropriate marketing strategies and tactics to increase recovery and recycling. By directing marketing efforts to contractors and government agencies, not only can the recovery of spent CCA lumber be enhanced, it may allow for the creation of new businesses and reduce the demand on our forests.

Recently, the research into the quantities of CCA treated lumber coming out of service and recovery/recycling options have drawn considerable interest. While there are several potential opportunities for recovered CCA lumber, contractor evaluations and beliefs concerning recovery, perceived barriers, recovery programs, facilities, remanufactured products, and product distribution have not been addressed until now. This research estimated that nearly 2.4 million cubic meters of CCA treated lumber were taken out of service nationally (in 1999), and Cooper (1993) estimated that over 18 million cubic meters will be taken out of service by 2020. This suggests a market opportunity exists for remanufacturing businesses related to recovered CCA lumber.

Initial research in the study identified through a mail survey to over 2,800 contractors and personal interviews, that the non-existence of recovery facilities is a critical factor in the recovery of used CCA lumber. Secondly, a lack of recovery programs was also identified as in a vital factor in recovery. Third, financial incentives should be instituted to facilitate the recovery of used CCA treated lumber. Cost, in one form or another, was also the most frequently mentioned suggestion to facilitate recovery. Finally, participants indicated that equipment and health risks appear not to be a hindrance to the recovery of CCA lumber.

One of the more salient findings concerned knowledge or the lack of knowledge regarding the disposal of CCA lumber and potential products that could be manufactured from spent CCA lumber. A small percentage of the respondents are completely ignorant regarding the chemical components of CCA treated lumber, they are unaware of the ramifications of burning used CCA lumber, as well as potential products that could be manufactured from recovered CCA lumber. As an illustration, several participants suggested the manufacture of fire logs from recovered CCA lumber. Contractors obviously are not aware of the regulations and dangers of the chemicals that comprise CCA. The treating, forest products, and retailing businesses clearly are not communicating with contractors effectively and this should be addressed immediately. The knowledge level discerned in this research not only has strategic implications towards the recovery of CCA lumber but to marketing in general as well. The primary implications are that marketers should strive to gain an understanding of the knowledge level of the customers and develop marketing communication campaigns to address the specific knowledge level of the customers.

The findings from model analyses indicate that contractor beliefs are significant factors concerning the recovery of spent CCA lumber. The belief findings lend strong support to the development and implementation of a marketing communications campaign to address key issues regarding recovery. These issues include information regarding why it is necessary to recover, societal and individual benefits, and health risks. The nonexistence of recovery centers and programs clearly moderates the contractor's decision intention and evaluation of recovery. This lends additional support for the development of recovery programs and facilities.

The findings of this research indicate that the recovery of spent CCA lumber will occur on a substantial basis only when the facilities, programs, and a marketing communications campaign are developed. Additionally, the promotional campaign will also have to be directed to state level and city/county waste management officials. The results from the case studies reveal dichotomies in both state and county level beliefs concerning the recovery of CCA lumber, were used CCA lumber is considered not to be a problem or it is considered to be a serious problem.

Marketing Strategy

In 1971, Kotler and Zaltman defined social marketing as "The design, implementation, and control of programs developed to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research."

Following Kotler and Zaltman, Shrum *et al*. (1994) envisioned recycling as managing the marketing mix. The recycling behavior or recycling program was operationalized as the product, recycling cost(s) as the price, and promotion (communication) being different strategies to reach diverse groups. Finally, distribution (place) may be thought of as the means to accomplish a given behavior.

Building upon the work of Kotler and Zaltman, and Shrum *et al*., the following is a conceptualization of a marketing strategy for the recovery of used CCA lumber. Each of the recommendations will be made by addressing the traditional *four-p's* of marketing.

In previous chapters it was recommended that both the treating and forest products industries become leaders in developing and implementing the recovery programs and facilities required for the recovery of spent CCA treated lumber. This researcher strongly suggests that the industries form a strategic partnership with state and local government waste management officials to develop these programs and facilities. The strategic partnership may also assist in creating a positive public image and reduce costs associated with the development of these programs.

These recommendations are not made lightheartedly; it is realized that the development of the programs will require substantial personnel, time, and monies. When one considers the financial and personnel requirements, it appears an unwieldy proposition; however, what are the alternatives? By idly standing by and doing nothing, both the treating and forest products industries risk the potential of negative publicity (of which the forest products industry should be well aware) resulting from both the leaching and disposal of spent CCA lumber.

Studies over the past decades have addressed attitude formation and beliefs, as well as research regarding methodologies for affecting attitude change. The consensus results from these studies indicate that once attitudes are formed, they are extremely difficult to change, even when copious sums of money and messages have been directed to change the prevailing attitude. Therefore delay in enacting both the promotional campaign and recovery/recycling programs could possibly be deleterious to the industries. In addition, both industries will lose the opportunity for a truly positive marketing communications campaign that extols the benefits of recovery and the "caring" services both industries are providing the public.

Several industries have developed recycling programs and actively partner with local governments; these industries include plastic, steel, aluminum, wooden pallets, and paper. These particular recovery programs could be utilized in developing a recovery program model for spent CCA treated lumber.

Place - Distribution

Place or distribution, refers to the availability and location of CCA lumber recovery facilities. Shrum *et al*. (1994) describe distribution as " . . . the manner in which the consumer participates in the behavior." Through the analysis and personal interviews, it became clear that the lack of recovery facilities was a significant impediment to recovery. Several suggestions were offered, including pickup programs and separate recovery facilities.

It appears the most viable option is the location of CCA lumber recovery sites within the county landfill, whether the facility is a MSW or a C&D facility. This setup would offer a convenient drop-off point for the contractors, and in this manner would require the least amount of participation from the contractor. The location of the recovery site within the landfill should also assist in word-of-mouth communications. The potential for contractors communicating among themselves about the recovery of CCA lumber will be greatly enhanced. Additionally, the recovery facility would not have to invest in technologies to identify treated lumber and they also have the equipment and manpower on site to begin the recycling process.

These facilities could also play a dual role, providing a drop-off point and providing a source for remanufactured products. Facility mangers should consider establishing a remanufacturing site, or a place where contractors could purchase remanufactured products. In addition, if viable products and distribution of the products are not attainable, the recovery sites can be utilized as a pickup site. The material could then be transported to regional or state facility sites. These facilities could provide storage until sufficient quantities are available for remanufacturing or processing. For example, if a chemical processing facility (e.g., steam explosion/wood liquefaction) were to be established, these sites could serve in a similar fashion as wood yards or log yards to processing industries.

Price

"Price can be conceptualized as the cost of the behavior" (Shrum *et al*., 1994). The price or recycling cost concerns the monies spent directly or indirectly to recover used CCA lumber. Participants indicated overwhelmingly that financial incentives should be instituted to facilitate the recovery, and incentives could be based on the pounds of material recovered, tax breaks or credits, or that tipping fees should not be charged for the returned material.

It appears that the elimination of tipping fees for recovered CCA lumber would be both simple and the most cost-effective; contractors must dispose of the used material in some manner. Conveniently located recovery facilities also addresses certain aspects of price, as convenient facilities reduce costs associated with time and transportation.

Promotion

Shrum *et al*. (1994) describe promotions as being intervention strategies, and can include several marketing communication tactics to reach the desired target to promote recycling. The importance of designing a marketing communications campaign that positively shapes contractor evaluations and beliefs was highlighted in this research. Promotional tactics for CCA lumber recovery could include recovery/recycling and material handling literature, educational programs, and advertising.

Literature should be made available that provides information concerning the necessity of recovery, address material handling, and the potential health risks of working with treated lumber. Educational programs should be offered, and include the sponsoring of clinics or seminars. The seminars could offer demonstrations of deck dismantling, proper handling, wood working techniques, and a demonstration for remanufacturing used CCA lumber into viable products. If advertising is a component of the campaign, an option is using local contractors in the ads. In this manner, area contractors could perhaps relate more strongly to the message being promoted.

Previously mentioned was word-of-mouth communications, this may be initiated and partially controlled by advertising (e.g., promotional literature) to the contractors. The program leaders should strive to develop literature that encourages contractors to talk about recovery techniques and the recovery of spent CCA lumber. Contractors inevitably talk with each other, and positive remarks concerning recovery cannot be underestimated. Word-of-mouth communications are considered a powerful tool in the marketers' arsenal and could be effectively employed with contractors. Another alternative would be the selection of contractors who recycle and then setting up a referral system with them, and possibly paying the contractors for their efforts.

Concurrent with the development of recovery facilities, a portion of the promotional effort could be designed to alter the degree of perceived barriers to recovery. The literature could be designed to convince contractors that the benefits of recycling spent CCA lumber outweigh the cost(s) of recovery. In addition, local media outlets should be contacted and invited to a deck dismantling, to an educational program, and to the recovery facility in order to create public awareness. Other literature could describe how the contractor can market their recovery operation to gain a competitive advantage over their competitors. The Charlotte - Mecklenburg recovery and recycling program provides a good model for the development of recovery literature.

Product

The operationalism for product (Shrum *et al*., 1994) is "The behavior or the recycling program is the product and it is being marketed to the general public or consumer." The recovery of spent CCA lumber (the product) is being marketed to deck builders and contractors, and the *product* is the recovery of CCA treated lumber. Given the population of interest, the marketing program should be directed to the target populations in the same manner, as well as to waste management officials.

Implementation

1) *Commitment* - The treating industry and producers of Southern yellow pine should commit themselves to designing and implementing recovery programs for CCA treated lumber. This will include allocating sufficient personnel, time, and monies to the project.

2) *Strategic Partnership* - Relationships should be developed with state-level waste management officials. These officials are in contact with city/county officials, and also are a source of recycling information. Additionally, the CCA recovery project probably will have to be test piloted in pre-selected cities. After review and adjustments, the program could be implemented on a wider scale. The relationships developed with state officials will assist in the aforementioned priorities. Working with these officials will also aid in the development of incentives, recovery sites, and a model for the development of the facilities.

3) *Recovery Program* - The recovery program will include recovery site locations, financial incentives, promotional campaign, and literature. The program should be well conceived and directed to both contractors and waste management officials.

4) *Promotion* - By working with state and local waste management officials, these individuals can direct program leaders to contractors they perceive to be leaders or would be approachable to recovery and recycling. Recovery literature should be mailed to contractors and made available at the recovery landfill site.

5) *Education* - Educational programs should be instituted, and can be held at the recovery site or at establishments such as Home Depot or Lowe's. The late fall to early spring time frame appears to be the most logical, as building generally slows during this period.

6) *Monitoring* - The program should be monitored continually and in all phases. This will allow for determination of successful or unsuccessful methods, and allow for the appropriate changes to be made in the program.

Future Research

This research focused on the factors affecting recovery and not on the manufacturing of products from recovered materials. The initiation of the recovery process is only the first step in the recycling chain. Recyclers apparently do not have options for the CCA lumber that they recover. This suggests that a viable product line must be developed, as well as a distribution system for the products.

The treating industry, the wood products industry, and university researchers need to develop a viable line of new products or processes for the conversion of recovered treated lumber. The development of recovery techniques and a viable product line cannot be undervalued. When one views the recovery/recycling programs and products today, one sees that the prices for the recovered materials are depressed. The end result is that many cities have dropped or dramatically cut back on their recovery programs. The prices received for the recycled materials do not cover the cost of recovery (King, 2000).

One of the findings from the study revealed several products and product applications in which used CCA lumber may be utilized. From the literature review, options include but are not limited to pyrolysis, steam explosion, liquefaction, wood-fiber cement composites, and traditional burial methods. Several participants indicated that remanufacturing and the availability of remanufactured products were critical to the success of recovery and recycling.

Further product research should include new chemical treatments currently coming to market, as an example Alkaline Copper Quaternary (ACQ), (Chemical Specialties Inc., 2001). ACQ is an alternative to present technologies that contain arsenic and chromium, and the preservative protects wood from rot, decay, and termite attack.

A simpler alternative appears to be kiln drying of treated lumber after it is removed from the charge. Tests could be conducted to contrast kiln dried treated lumber against non-kiln dried treated lumber for the leaching of heavy metals. Additionally, kiln dried CCA treated lumber could be positioned to be differentiated from traditional CCA treated lumber.

Another project relating to cost would contrast the price of a deck fabricated with new materials to the cost of a deck built with recovered and remanufactured materials. The cost of the remanufactured deck should also include the cost of nail pulling, transportation, etc. The purpose would be to discern if remanufactured parts are an economically viable alternative.

Research should address the issues of financial cost to the contractor. While two of the constructs in this study could be considered economic in nature, participants could be asked direct questions concerning financial cost. The influence of cost on the contractors' decision intention to recover may be revealed. In addition, financial costs also may be strong predictors of the recovery intention.

After recovery facilities and programs are put in place, research could be conducted to ascertain the impact of the perceived behavioral control components and beliefs have on the contractors' decision intention to recover. Specifically, which construct plays a more important role, perceived behavioral control or beliefs? It may be found that perceived behavioral control affects beliefs, and strengthens the belief constructs role in explaining the decision intention.

Finally, replication of this study to other geographic areas of the United States perhaps could expand the external validity of the results. After the recovery programs and facilities are established, a research project could be conducted to measure the impact of interventions. Further research into contractor attitudes would be useful in explaining the effect of motivation on the contractors' decision intention, and specify which interventions are more effective (e.g., economic incentives vs. persuasive appeals).

Study Limitations

Most research is conducted with several parameters, and in this study time and money were such parameters. Each geographic region of the United States was not sampled, theoretically meaningful questions could not be asked due to time and money constraints, and keeping the questionnaire within reasonable length in order to limit participant time in answering the questionnaire were all limiting parameters. Additionally, not every factor regarding research can be anticipated. This study was developed to gain an understanding of the factors that influence a contractor's decision intention to recover used CCA treated lumber.

This research was conducted in the States of Georgia, North Carolina, and South Carolina. The results may be generalizable in the Southeastern United States, however for the results to be more generalizable, it would have been necessary to sample contractors from all regions of the United States.

Another possible limitation to this study was that the data were from a self-elicitation questionnaire and were collected by utilizing a mail survey. As a result of the data being collected at the same time, common method variance may explain some of the variance. However, common method variance is not plausible in this study as a result of the significant interaction found between evaluations and external control. Participants would have to have known implicitly the theory being tested for this type of bias to explain the interaction.

Additionally, Harmon's one factor test was utilized (Podsakoff & Organ, 1986), and results from the factor analysis indicate that the variables of interest loaded on more than one factor. In addition, one general factor did not account for the majority of covariance among the independent and dependent variables. While these results did not conclusively rule out the possibility of common method variance, the results indicate that such a bias is not a plausible alternative explanation for the findings.

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Appendices

Appendix A – Prenotification Letter

July 26, 2000

Dear Mr. :

In the upcoming days you will receive a request to complete a brief questionnaire. We are mailing it to you to learn how you feel about the recovery of Chromated Copper Arsenate (CCA) treated lumber used to construct outdoor decking. In addition, we will estimate the quantities of CCA treated lumber being removed from service with the information you provide us.

As you may know, recent reports indicate that large quantities of CCA lumber are currently being removed from service and this is projected to increase in the future. Results from this project will yield new uses or products and potential reduced disposal fees for used CCA treated lumber. Additionally, this project is being conducted to better inform the treating and forest products industries, government officials, and others who will make decisions related to the recovery, recycling, and disposal of CCA treated lumber.

You are one of the small number of people who are being asked to give their opinions on this matter. We will offer you the opportunity **to win a $200 gift certificate** from Home Depot. To be eligible to win the certificate, you must complete and return the questionnaire. One participant will be randomly selected from the respondents. Additionally, a summary report of the results obtained from this research will be available to those who participate in this research.

Your participation and comments will be greatly appreciated and will contribute to the success of this project. *Thank you in advance for your help.*

Sincerely,

Delton Alderman
Graduate Research Assistant
Virginia Tech

Appendix B – Mail Survey Questionnaire

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

ISSUES CONCERNING CCA TREATED LUMBER REMOVED FROM RESIDENTIAL DECKING

Center for Forest Products Marketing and Management
Department of Wood Science and Forest Products
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

If you have any questions, please call, fax, or email:
Delton Alderman
Phone: 540 – 231 – 5876
Fax: 540 – 231 – 8868
email: dalderma@vt.edu

Recent reports indicate that the quantities of used Chromated Copper Arsenate (CCA) treated lumber being removed from service are increasing rapidly. This research project seeks to identify the factors that affect the potential recovery of used CCA treated lumber. One of the primary goals of this project is to develop estimates of CCA treated lumber being removed from service. Another goal seeks to identify the factors that could or do affect the recovery of used CCA treated lumber. ***All responses are strictly confidential.*** If you are not directly involved in the construction, repair, or demolition of residential decks, please give this questionnaire to a coworker or associate who is.

Thank you for participating in this project!

Do you or your company build or demolish residential decks? Please check below.

____Yes

____ No. If no, please fold and tape the questionnaire, and return to us (postage is prepaid). ***Thank You.***

1. How many decks did you build in 1999? ________________ (total number)

2. What was the average size (10'x10'; 20'x30') of the decks that you built in 1999? _____ feet by _____ feet

3. How many decks did you demolish in 1999? ___________________ (total number)

4. What was the average size (10'x10'; 20'x30') of the decks that you demolished in 1999? _____ feet by feet

5. Would you please estimate the average age of the decks that you removed in 1999? ________ years

6. When replacing a deck, do you primarily ….. (Please indicate the percentage below.)

Build a new deck	_______%
Replace deck boards	_______%
Replace deck railings	_______%
Replace stair treads	_______%
Replace deck lattice	_______%
Replace joists/stringers	_______%
Other	_______%; Other _________________________
TOTAL	**__100__ percent**

7. What was the average cost of disposing a demolished deck in 1999? $ ________

8. What would be the additional cost of dismantling a deck for recovering used CCA treated lumber versus the cost of demolishing a deck? $ ________

9. In your opinion, what percentage of decks are repaired or built by the homeowner? ___________ %

The following questions deal with the potential recovery, reuse, or recycling of used CCA treated lumber. For example, in landscaping, odd jobs, stakes, or processed into engineered wood products (e.g., OSB, landscape ties, poles) rather than taking the material to the landfill.

10. When you demolish a deck, what percentage of used CCA lumber could potentially be recovered? _________%

11. If you dismantle decks and recover used CCA treated lumber instead of demolishing them, what percentage of the used CCA treated lumber could be recovered? _____________ %

12. What percentage of the CCA treated lumber that you buy to construct a new deck is discarded? (For example, as scraps, end trims, temporary supports, etc.) _____________ %

13. Please rate the following factors as to why homeowners replace existing decks, where 1 = least important to 7 = most important.

	Least Important						Most Important
Aesthetics - wood appearance	1	2	3	4	5	6	7
Decayed wood	1	2	3	4	5	6	7
Insect infested wood	1	2	3	4	5	6	7
Style – a new style of deck preferred	1	2	3	4	5	6	7
Safety – structurally unsound deck	1	2	3	4	5	6	7
Poorly constructed deck	1	2	3	4	5	6	7
Size – a larger deck preferred	1	2	3	4	5	6	7
Material – a new material preferred	1	2	3	4	5	6	7
Physical degradation – warp, splits, twist, bow	1	2	3	4	5	6	7
Other, please list the other reason(s)	____						
	____						

14. What **primary** method of disposal do you use to discard CCA treated lumber? (Please indicate the percentage below.)

Landfill CCA treated lumber at a municipal solid waste facility	_______%
Contract the disposal of used CCA treated lumber	_______%
Landfill CCA treated lumber at a private facility	_______%
Landfill the CCA treated lumber at a construction and demolition facility	_______%
Do not dispose of CCA treated lumber, but recover for reuse or recycling	_______%
Burn CCA treated lumber	_______%
Other, please list the disposal method __________________________	_______%
TOTAL	**100 percent**

The following statements focus on your attitudes toward recovery and recycling.

15. My attitude towards recovery and recycling in general is . . . (Please circle one number only.)

Extremely Favorable		Somewhat Favorable	Neither Favorable or Favorable	Somewhat Unfavorable		Extremely Unfavorable
+3	+2	+1	0	-1	-2	-3

16. All things considered, if recovery centers and recycling programs were available, my attitude toward recovering used CCA lumber is . . . (Please circle one number only.)

Extremely Favorable		Somewhat Favorable	Neither Favorable or Favorable	Somewhat Unfavorable		Extremely Unfavorable
+3	+2	+1	0	-1	-2	-3

17. For me personally, my attitude toward the recovery of used CCA treated lumber being a beneficial act can best be described as . . . (Please circle one number only.)

Extremely Favorable		Somewhat Favorable	Neither Favorable or Favorable	Somewhat Unfavorable		Extremely Unfavorable
+3	+2	+1	0	-1	-2	-3

The following statements focus on the recovery of used CCA treated lumber.

18. There is a need to recover discarded CCA treated lumber. (Please circle one number only.)

Strongly Disagree		Slightly Disagree	Neither Agree or Disagree	Slightly Agree		Strongly Agree
-3	-2	-1	0	+1	+2	+3

19. The recovery of used CCA treated lumber poses a health risk. (Please circle one number only.)

Strongly Disagree		Slightly Disagree	Neither Agree or Disagree	Slightly Agree		Strongly Agree
-3	-2	-1	0	+1	+2	+3

The following statements focus on your beliefs toward recovering used CCA lumber.

20. I believe that if recycling programs or centers were available, I would recover used CCA lumber (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

21. I believe that the recovery of used CCA treated lumber is a beneficial act (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

The following statements focus on yours and other's thoughts about recovering used CCA lumber.

22. I would feel guilty if recycling centers were available and I did not recover a large portion of my used CCA treated lumber. (Please circle one number only.)

Strongly Disagree		Slightly Disagree	Neither Agree or Disagree	Slightly Agree		Strongly Agree
-3	-2	-1	0	+1	+2	+3

23. My coworkers and other builders expect me to recover used CCA lumber. (Please circle one number only.)

Strongly Disagree		Slightly Disagree	Neither Agree or Disagree	Slightly Agree		Strongly Agree
-3	-2	-1	0	+1	+2	+3

The following statement focuses on your intention to recover used CCA treated lumber.

24. Please express how likely your intention is to begin the recovery of used CCA treated lumber. (Please circle one number only).

Quite Likely		Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely		Quite Unlikely
+3	+2	+1	0	-1	-2	-3

The following statements focus on your having the ability to recover used CCA lumber.

25. Please indicate how easy or difficult it is for you personally to begin recovering used CCA treated lumber. (Please circle one number only.)

Extremely Easy		Moderately Easy	Neither Easy or Difficult	Moderately Difficult		Extremely Difficult
+3	+2	+1	0	-1	-2	-3

26. The recovery and recycling centers necessary for the disposal of or collection of used CCA treated lumber are available. (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

27. Currently recycling programs are in place for recovering used CCA lumber. (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

28. I can haul used CCA treated lumber a greater distance (to a collection center) than other construction wastes. (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

29. I have the time to recover used CCA lumber. (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

30. I have the manpower to recover used CCA lumber. (Please circle one number only.)

Strongly Agree		Slightly Agree	Neither Agree or Disagree	Slightly Disagree		Strongly Disagree
+3	+2	+1	0	-1	-2	-3

31. Please rate the importance of the following factors that may hinder the recovery of used CCA treated lumber, where 1 = least important to 7 = most important.

	Least Important						Most Important
Time	1	2	3	4	5	6	7
Manpower	1	2	3	4	5	6	7
Equipment	1	2	3	4	5	6	7
Lack of recycling programs	1	2	3	4	5	6	7
No recycling facilities	1	2	3	4	5	6	7
Health risk	1	2	3	4	5	6	7
Cost	1	2	3	4	5	6	7

32. In your opinion, what incentives or programs could be instituted to start or improve the recovery and recycling of used CCA treated lumber?

____

____

____

33. What products do you believe can be made from used CCA treated lumber?

____

____

____

34. Is there something we should have asked concerning the recovery and recycling of used CCA treated lumber that we did not ask?

____

____

If you have any questions regarding this research, please feel free to contact me:

Delton Alderman
Phone: 540-231-5876
Fax: 540-231-8876
Email: dalderma@vt.edu

Again, Thank you for your participation.

VIRGINIA TECH
THOMAS M BROOKS FOREST PRODUCTS CENTER
CENTER FOR FOREST PRODUCTS MARKETING & MANAGEMENT
ATTENTION: DELTON ALDERMAN
1650 RAMBLE ROAD
MAIL CODE 0503
BLACKSBURG, VA 24061

« «

Please fold along the bottom of the arrows

Please return the questionnaire after folding in half and taping the ends together (*Please do not staple)*. Before mailing, please make sure that the return address is visible. **The postage is prepaid**.

THANK YOU!

Appendix C – Reminder Postcard

Dear Builder:

I need your help! About two weeks ago I mailed you a questionnaire titled **"Issues Concerning CCA Treated Lumber Removed from Residential Decking."** The questionnaire is a key component of this project and your input is essential to the project's success. The questionnaire is designed to gain a better understanding of the factors surrounding the construction and demolition of residential decking constructed from CCA treated lumber.

I am contacting you to ask that you please complete the questionnaire. If you have already returned it, please accept my appreciation and disregard this postcard. If not, please take a few minutes to fill out the questionnaire at this time. Remember that by completing and returning the questionnaire you will be eligible **to win a $200 gift certificate** from Home Depot.

Your response is critical to the successful completion of this project. Should you have any questions please contact me at (540) 231-5876. *Thank you in advance for your participation.*

Sincerely

Delton Alderman
Graduate Research Assistant
Center for Forest Products Marketing and Management
Virginia Tech

Appendix D – Case Study Questionnaires

State Waste Management Officials

1. What is your state's current policy towards the disposal of CCA lumber?

2. Do you have an estimate on quantities of CCA lumber directed to your state's landfills?

3. Are you aware of any recovery and recycling programs for the CCA treated lumber, either in the Southeast or in United States?

Building Inspectors

1. In your opinion, what was the average size of the deck built in 1999?

2. In your opinion, what percentage of decks were built by the owner in 1999?

3. In your opinion, what were the primary materials (e.g., treated lumber, wood-composite lumber) used to construct a deck?

4. Do you remember issuing any permits for the demolition of a deck(s) in 1999?

Landfill Managers

1. Does this facility separate CCA treated wood or mix it with the rest of the debris?

2. What is your primary method of disposal?

3. Is CCA treated lumber considered to be a contaminated material?

4. Are there any programs for the recovery and recycling is CCA treated wood?

5. Could you quantify the amount CCA treated lumber that enters your facility?

6. What programs or incentives could be instituted to begin the recovery and eventual recycling is CCA treated wood?

7. Have you received any information about recovery programs from the surrounding area or from the U.S.?

Contractors

1. How many decks did you build or dismantled in 1999?
   What was the average size ____ and what was the average age _____?
2. When demolishing a deck, what percentage do you recover?
3. What are the major problems with dismantling a deck for recovery?
4. What programs or incentives could be established to start or improve the recycling of used CCA treated lumber?
5. What products can be produced from used CCA treated lumber?
6. What type of landfill do you take the used materials to dispose of them?
7. Are there any tricks of the trade that you could relay to those who are interested in dismantling and recovering used CCA treated lumber?

Appendix E

VITA

Delton R. Alderman, Jr.

Delton R. Alderman, Jr. was born in Galax, Virginia on May 31, 1958. He earned his B.S. in Forestry and Wildlife Science from the Virginia Polytechnic Institute and State University in 1982 and earned his M.S. in Wood Science and Forest Products from the Virginia Polytechnic Institute and State University in 1998. Before returning to school for his masters, Delton worked as both a procurement and private consulting forester in Virginia and North Carolina. Delton also served the nation through his service to AmeriCorps and the USDA Forest Service as a designer and fabricator of portable timber bridges. Delton continued his graduate work in wood products at Virginia Tech after receiving the USDA National Needs Fellowship. Delton's interest in forest products arises from over fifteen years experience in the forestry and forest products industries.