Eco-labeled wood products in the U.S. residential construction industry: Architects' awareness and usage of certified wood and green building programs

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ABSTRACT

The use of environmentally friendly building materials has experienced slow growth within the residential construction market due to higher cost and low availability of certified wood. The development of green building programs (GBPs) marked the beginning of the effort to adopt energy-efficient design guidelines and utilize eco-friendly renewable materials in structures. These programs were targeted at reducing environmental impacts by integrating eco-friendly materials into the design and construction of buildings, including promoting the use of environmentally certified wood products (ECWPs) harvested from sustainably managed forests. This research was designed to determine which attributes influence architects' decisions to use environmentally certified wood products in residential construction projects and how this might influence their perceptions and use of green building programs. The results indicate that architects who have participated in a GBP were more likely to have used ECWPs. The material attributes that influence architects' selection of materials are mainly related to economics and function as opposed to environmental friendliness. These results will help to inform and broaden the understanding of issues that influence the adoption and utilization of environmentally certified wood products, and identify some of the factors that can contribute to their continued growth in the U.S. marketplace.

Keywords: environmentally certified wood products, residential green building programs, adoption and diffusion of innovative products and programs

RÉSUMÉ

L'utilisation de matériaux de construction écologiques a connu une lente progression dans le secteur de la construction résidentielle à cause des coûts plus élevés et de la faible disponibilité du bois certifié. Le développement des programmes de construction écologique (PCE) a marqué le début des efforts d'adoption des directives d'efficacité énergétique et d'utilisation de matériaux renouvelables et éco-respectueux pour la construction. Ces programmes visaient à réduire les impacts environnementaux en intégrant des matériaux éco-respectueux dans la conception et la construction d'édifices, ainsi qu'à promouvoir l'utilisation de produits de bois certifiés respectueux de l'environnement (PBCRE) récoltés dans des forêts sous aménagement durable. Cette recherche a été conçue pour déterminer quelles caractéristiques influencent les décisions des architectes d'utiliser des produits de bois certifiés respectueux de l'environnement dans des projets de construction résidentielle et comment cela pouvait influencer leurs perceptions et l'utilisation de programmes de construction écologique. Les résultats indiquent que les architectes qui ont utilisé de PBCRE étaient plus susceptibles d'avoir participé à un PCE. Les caractéristiques des matériaux qui influencent le choix des architectes sont essentiellement reliées à des questions économiques et d'utilisation plutôt qu'à des raisons de respect de l'environnement. Ces résultats aideront à informer et à accroître la compréhension des enjeux qui influencent le choix et l'utilisation de produits de bois certifiés respectueux de l'environnement, ainsi qu'à identifier un certain nombre de facteurs qui peuvent contribuer à leur plus grande utilisation au sein du marché américain.

Mots clés : produits de bois certifiés respectueux de l'environnement, programmes de construction résidentielle écologique, choix et diffusion de produits et de programmes innovateurs

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Introduction

Innovation of building materials and design continues to evolve in the U.S. as fuel costs rise and the need for energy-efficient residences increases. The development of green building programs in the late 1990s was the beginning of implementing energy-efficient building design guidelines and eco-friendly renewable materials that reduced impacts on the environment. Green building programs provided a way to have a structure certified as meeting specific design standards and thereby be given an eco-label as having been built or "designed for the environment". It has only been in the last decade that green building programs (GBPs) have been developed for residential housing so that consumers can enjoy energy and water savings for a small to medium increase in initial home costs. GBPs try to integrate eco-friendly materials into the design and construction of the home, including certified wood products sourced from sustainably managed forests (although certified wood is not required to achieve third-party certification).

In the home construction supply chain, architects typically specify the materials that are going to be utilized in a building project. It is their choice of eco-friendly or energy-efficient materials that determines the carbon footprint of a home, whereas homebuilders have the task of procuring the necessary materials and properly installing them to maximize their eco-friendly attributes. In the case of environmentally certified forest products (ECWPs), most of the timber harvested from certified forests was manufactured into value-added manufactured products (e.g., cabinetry, moulding, millwork and flooring). The development of residential green building programs (RGBPs) has provided a marketplace for certified structural materials, such as dimension lumber and structural plywood and particleboard. RGBPs award green building points if a certain percentage of certified wood products have been used to build a home.

The focus of this research is to determine architects' familiarity with ECWPs and residential green building programs and the reasons they are or are not using them. It also attempts to determine if the usage of ECWPs is associated with the participation in RGBPs. The study looked at which material attributes are the most important in influencing architects' decisions to utilize ECWPs in the design of a building. Architects' might be inclined to select certain materials based on their environmental friendliness and energy efficiency, or they may be looking to meet certain economic and functional requirements. Understanding how architects perceive and specify environmentally friendly materials could potentially open the marketplace for ECWPs . In addition, there may be specific groups of architects (e.g., those located in environmentally progressive areas) who are more likely to use RGBPs or specify ECWPs. If differences exist between architects or patterns emerge, marketing efforts could be targeted towards each group's preferences. Concentrating marketing efforts towards a specific market segment could increase efficiency in the distribution of information materials and programs. Understanding the adopter segments of a market could also allow organizations to reduce market expenditures while increasing the success of a new product introduction (Fell *et al.* 2002).

Research Questions and Objectives

Based on an online survey of architects in the U.S., this study seeks to accomplish the following tasks: 1) understand what demographic factors influence the awareness and usage of environmentally certified wood products in the U.S., 2) determine if residential green building programs drive the usage of ECWP in general or if certain RGBPs relate to specific ECWPs, and 3) explore the importance of individual product attributes of the specification and usage of ECWPs.

One contribution of this study to the green building literature will be providing empirical evidence of architects perceptions and usage of RGBPs and ECWPs. Past research on green building has been largely focused on home builders in North America and abroad (Aguilar and Vlosky 2008), with only a few studies dedicated to U.S. architects (Kozak and Cohen 1999, Wagner and Hansen 2004). This study seeks to fill this void and provide updated information on architects' usage of RGBPs and their specification of certified wood products. Results of this study may help green building certification organizations better understand the factors that help promote the usage of RGBPs within the architectural community as it may be the key link between the increased awareness and usage of these programs.

Background

Design professionals usually choose their materials based on what they have experience with, and material utilization is influenced by perceptions. For example, some architects may specify steel studs instead of wood because they perceive that steel studs have higher strength and better durability than wood, while some architects may believe that steel is more environmentally friendly than wood (Wagner and Hansen 2004). This perception of environmental friendliness could be a result of the steel coming from recycled material or the high value of recycled steel on the secondary market. Often, the barriers to using wood are attributed to building codes, design difficulty, and poor performance in fires and durability (Kozak and Cohen 1999). Oster and Quigley's (1977) study on innovations in the construction industry confirmed that building codes were indeed perceived to be a hindrance in design and technology utilization.

The vast majority of residential homes in the U.S. are built from wood and new residential construction has traditionally been the largest market for softwood lumber in the U.S. However, the recent housing crisis caused housing starts in the U.S. to plummet from 2.2 million in 2005 to 554 000 in 2009 and in 2013 housing starts remained below 1 million (NAHB 2014). During this time, the proportion of softwood lumber consumed within residential housing fell from 43.5% in 2005 to 23.3% in 2009 before rebounding to 26.6% in 2012 (WWPA 2013). As a result of the recent housing and economic collapse, many softwood lumber manufacturers have begun exporting their wood products overseas to Asia.

Prior to the collapse of the housing market, and as a way to make their products more appealing to environmentally oriented builders, architects and home owners, an increasing number of forest owners and wood products manufacturers have adopted third-party certification and chain-of-custody certification. This move towards certification has also helped forest products companies meet external pressures from environmental nongovernment organizations (ENGOs), local governments, wood remanufacturers, and the general public, to adopt more sustainable forest management practices. These types of eco-label certification allow manufacturers to demonstrate that they have committed to integrating sustainable forestry practices into their business practices. Even as the industry has moved towards forest certification, low levels of awareness among potential end users of ECWPs (e.g., home builders and architects), unreliable availability of supply, and premium pricing (Ganguly *et al.* 2008, Irland 2007), there have been few incentives for architects to incorporate ECWPs into their projects. However, RGBPs offer a market-based incentive for incorporating ECWPs into a green building project by providing points for their use in a residential project looking to achieve a certified status.

Many home builders feel that certification helps attract buyers and renters because of a growing public interest in sustainable lifestyles (McCormick 2008). A 2009 study by McGraw Hill found that certified homes generated 3.5% higher occupancy rates and 3% higher rental rates than did conventional buildings, and they provide a 6.6% higher return on investment. Architects and builders who build green take advantage of additional market opportunities because of a new generation of younger, more informed and environmentally aware home buyers and their expectations for more efficient and sustainable homes. Despite the recent downturn in new home construction, McGraw-Hill Construction (2009) predicted that the overall green building market would double by 2013. The increase in the green construction market can be attributed to a number of factors, including the public's growing awareness of green building practices and green building materials, the increase in government interventions, and the recognition of bottom line cost advantages (Vlosky *et al.* 2008).

Forest certification in the U.S.

A steadily growing volume of wood used in residential construction is from third-party certified forests in the U.S. However, it should be noted that lumber produced from certified forests is not always labeled as being certified because of the higher cost of producing certified lumber and the absence of price premiums for certified lumber in the marketplace. There are two main forest certification bodies in the United States: the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI). By the middle of 2011, there were 56.8 million ha of forests certified under the FSC program in North America and by comparison approximately 153.8 million ha of forest were certified under the PEFC program in North America (FSC 2011, PEFC 2011). PEFC is the Program for the Endorsement of Forest Certification that embraces other forest certification schemes in addition to SFI (e.g., the American Tree Farm System) under its umbrella system, and as of 2012, it had endorsed 30 national certification programs worldwide with over 240 million ha of certified forest land (PEFC 2013).

The Forest Stewardship Council, the first international certification program, was introduced in 1993. FSC provided a framework for forest owners and governments to have third-party oversight of their operations. FSC certification is typically favored by ENGOs over SFI (Gullison 2003) because of the involvement of multiple stakeholders, public (e.g., governments, ENGOs) and private (e.g., industry, landowners). An important distinction between the two standards is that FSC has an international focus, as opposed to SFI, which is only used to certify lands in the U.S. and Canada (SFI 2011).

Each of these programs comes with an eco-label that is stamped on the material that has been certified under either of these standards. This provides an easy way for consumers to know they are purchasing wood from sustainably managed forests. The addition of an eco-label can be utilized as a marketing instrument allowing for differentiation of a product and accentuating its environmental friendliness.

The idea behind third-party certification of sustainable forest management practices has always been that customers would be willing to pay a premium for wood products from sustainably managed forests. A study by Vlosky *et al.* (1998) showed that customers are not willing to pay a price premium for certified wood, so non-market-based incentives such as residential green building programs, may help by providing an incentive for home builders and architects to use certified wood. This research considers the factors that influence architects' specification and use of ECWPs. ECWPs, such as structural softwood lumber that are used to build a home, are essentially sold as commodity products. As such, they are specified based on their performance characteristics as a structural building material. There is no discernible difference between certified or non-certified structural softwood lumber (since all structural lumber has to meet uniform wood grading and quality standards). This is essentially the crux of the marketing challenge confronting certified structural lumber. It is a commodity product that is generally hidden within the walls of the house where it is not visible and therefore it is extremely difficult to command a price premium for this type of product. RGBPs, with their point-based systems, provide an opportunity to increase the demand of certified structural lumber that could potentially command a modest price premium.

Green building programs

Green building programs in the United States were developed to increase the energy and water efficiency of buildings while reducing waste from the daily operation of buildings. A majority of the natural resources in the U.S. are consumed during the daily operation of commercial and residential buildings. In 2010, buildings in the U.S. accounted for 13% of the total potable water consumed and 72% of the total electricity consumed, while constituting 39% of the total CO_2 emissions (USGBC

2010). To help improve building efficiency, design professionals and industry managers needed a framework that could help to design, build and operate more resource efficient buildings.

In recognition of this need, the non-profit United States Green Building Council (USGBC) created the Leadership in Energy and Environmental Design (LEED) program in 1998 as a way to rate commercial buildings based on their performance on specific design criteria. LEED was offered as a way to voluntarily certify a commercial structure as being "green" if it met the program requirements. In response to interest within the residential construction sector, LEED for Homes was developed as a sub-category of LEED that focuses on residential buildings. Within any LEED program, there are certain prerequisites that every building needs to meet in order to gain points and qualify for the various levels of certification: Certified, Silver, Gold, and Platinum. LEED for Homes, like many of the other LEED programs, is comprised of five major credit categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, plus some additional points for Innovation and Design and Regional Priority Credits.

The National Association of Home Builders (NAHB) also has a residential green building program called the National Green Building Standard (NGBS). Established under the partnership of the NAHB and the International Code Council (ICC) in 2007, NGBS was the first residential green building rating system to go through consensus development (NAHB 2012). NGBS was designed from its inception to focus on residential structures, while LEED for Homes was a restructure of the original LEED standard that was developed for commercial buildings. Similar to the LEED for Homes program, NGBS awards points in a series of categories (energy efficiency, water conservation, resource conservation, indoor environmental quality, and site design). There are certain prerequisites that homes need to meet, but they generate credits at the levels of Bronze, Silver, Gold, and Emerald.

In comparing the LEED for Homes and NGBS green building programs, a number of differences can be seen, especially regarding the use of ECWPs. The NGBS accepts the usage of ECWPs that are certified under all third-party certified forest product programs, including both FSC and SFI, whereas LEED for Homes only awards points when FSC-certified wood is used. Hence, under the LEED for Homes program, no points are awarded for homes built using certified wood harvested from the dominant sustainable forest management programs in North America. The exclusion of these certification has been blamed for the constrained supply of certified wood in the market and has limited the adoption and diffusion of certified wood within the residential construction sector. As a result, there continue to be issues in procuring FSC-certified wood because of the long lead times required to purchase adequate supplies of FSC wood (Irland 2007), and the constrained supply of FSC-certified wood will continue to limit the usage of certified wood by green builders (Germain and Penfield 2010). Knowles *et al.* (2011) noted that architects had problems designing large wood-framed buildings because of problems in sourcing adequate supplies of FSC-certified wood. This supply constraint has been an ongoing issue and the FSC has tried to address this by providing new mixed-source labels for lumber that contains a mix of FSC and non-FSC woods.

The usage of ECWPs are optional in both the LEED for Homes and NGBS green building programs, and the total number of points available for the usage of certified wood is specified within the Materials and Resources chapter in LEED for Homes and the Resource Efficiency chapter in the NGBS (USGBC 2010, NAHB 2012). Using ECWPs in a home can generate points in LEED for Homes when they are used in two of three structural applications within the home (e.g., roof, floor, or wall systems for 0.5 points each), or by being used as an environmentally preferable material in a fence or driveway (0.5 points for each). The maximum amount of points gained from the use of ECWPs is eight. To meet each certification threshold there needs to be prerequisites met in all five categories with a total of 45 points for a rating of Certified, 60 points for Bronze, 75 points for Gold, and 90 points for Platinum. Wood that is tropical of origin has to be FSC-certified or reclaimed.

As part of the National Green Building Standard (approved by ANSI/ICC-700 2008), ECWPs can earn green building points in two ways, the first is under section 606.2 where structural wood based products used in at least two major elements (e.g., roof, floor) of the project are certified to the requirements of any of the approved forest certification programs, while the second is under section 606.2(1) where a minimum of two certified wood-based products are used for non-structural elements of a building (such as all of the trim, cabinetry, or millwork). The maximum number of points to be gained from using ECWPs in NGBS is seven. After meeting prerequisite point totals in each category, the hierarchy of certification levels in NGBS is a minimum of 231 points for Bronze, 349 for Silver, 509 for Gold, and 641 for Emerald. Even though there are not a significant number of points attributed to certified wood under either program (relative to the total number of points to gain even the basic level of certification), the usage of ECWPs can provide a home with an additional eco-label for using certified wood. This eco-label can be featured in the promotion of the home and therefore could make it more marketable and perhaps even command a price premium in environmentally sensitive markets.

Currently, the NGBS suffers from a lack of awareness among builders and architects. By the end of 2012, there were almost 33 000 housing units that had been certified under the LEED for Homes program while fewer than 6000 housing units had been certified under the NGBS program (USGBC 2013, NAHB 2014). This study tries to identify some of the factors that have affected the adoption and use of the two green building programs.

Research Methods and Data Analysis

Methodology

An online survey was utilized to collect information for this study. This allowed for a quicker and cost-effective way to reach our target population. A web-based survey allows for the set-up of logically sequenced questions that allows respondents to only answer the relevant questions of which they would have knowledge. For example, if a respondent reports they have used a green building program, they would then be asked to rate the top three reasons for using it, whereas the program would automatically skip this question for a respondent who had not used a green building program. The survey also allowed respondents to take a pause from the survey and resume where they left off, thereby reducing any type of survey fatigue. The survey was powered by Qualtrics (Qualtrics Labs, Inc., version 2011), a web-based survey software. Qualtrics is a software package that records completed responses into a database as they are submitted by the respondent.

Survey design and data collection

The population of interest in this study was architects who had designed residential homes in the United States in 2010. The residential home industry is the largest consumer of wood products in the U.S. and architects are heavily involved in the specification of wood products in home design. There were 105 596 architects registered in the U.S. in 2010, 80 000 of whom were also registered as members of the American Institute of Architects (AIA). Of the 80 000 AIA-registered architects, only a small percentage actually work within the residential housing sector. Architectural firm revenues from residential housing nationwide average around 8% for multi-family residences and 6% for single family homes (AIA 2012).

Working with the AIA, we generated a random sample of architects who were sent an email explaining the purpose of the research along with a link embedded in the email to direct them to the research questionnaire. The sample size was calculated based on the variable of interest in this study, which was architects who had designed a home registered with a green building program (Cochran 1977). The following equation was used to generate the proper sample size (Krejcie and Morgan 1970):

$$n = \frac{\chi^2 NP(1-P)}{d^2(N-1) + \chi^2 P(1-P)}$$

where n = required sample size; N= the target population size; P= the estimated value for the proportion of a sample who are aware of GBPs; d = acceptable margin of error for the estimated value of P; χ^2= table value of chi square for one degree of freedom relative to the desired level of confidence, (1-d). The target response rate for the survey, which was set at 20%, required that we receive at least 400 completed surveys from the sample population. This response level was determined by the presumed awareness of ECWPs by architects (50%) and would provide enough data to reach the highest required sample size for a desired level of accuracy (5%) (Cochran 1977). The survey received 509 responses, which exceeded our minimum level of completed surveys. If a response to a survey becomes too large, more questions tend to have significant results and therefore the survey was cut off at that point.

The survey was pre-tested by AIA members for clarity and validity prior to being sent out to survey respondents. Since all respondents would be administered the same survey, most of the unreliability was eliminated. However, given the logical structure of the questions built into the survey, each respondent was not required to answer every question. Respondents only answered the questions that were appropriate based on their responses to previous qualifying questions. The reliability of this measure was verified with AIA by similar questions they utilize to generate demographics of their members.

Results and Discussion

Respondent demographics

From the 509 respondents, approximately 95% were architects, of whom 50% worked for an architectural firm, 22% worked as independent consultants, and the remainder were engaged in other activities (e.g., a combination of design–build operations). In describing their client type, 64% of the survey respondents worked primarily for homeowners, with 15.5% working for home builders, and 4.5% working for other architect, design, or engineering firms, and the remainder responded "other". In regards to firm size, based on the number of homes designed and/or built, many of the respondents were unable to answer this question although each respondent had participated in at least two home designs in 2010 (the minimum requirement to be qualified to participate in the survey).

To gauge firm experience, architects were asked to report the number of years that their firm had been in business. Experienced firms have more extensive social and professional networks, consisting of other competitors, suppliers, architects, builders, developers and government officials, which might help increase the likelihood that they would be aware of, and be more willing to use, RGBPs. In contrast, the general belief is that younger architects would be more likely to be sensitive to environmental issues and therefore more aware of RGBPs. There are a number of theories offered in support of these beliefs, but the most common argument is that those who have grown up in a time period in which environmental concerns have been a relevant topic are more likely to be sensitive to these issues (Straughan and Roberts 1999).

Though age studies are far from conclusive, there is reason to believe that firm experience could be a factor, since years in business gives a firm a higher likelihood of being involved with a green building project or of specifying environmentally certified wood products. Experience could also be linked to continuing education from professional training and seminars; although education was not measured directly in this study (Straughan and Roberts 1999). For this analysis, architects were classified into groups. The mean level of business experience reported by respondents was 24.1 years (n = 457), Table 1. The survey results follow a relative normal distribution.

Another demographic variable considered was the area where the respondent conducted business (by population density) as explored by Ganguly and Eastin (2007). Location of business (Hounshell and Liggett 1973, Samdahl and Roberts 1989, Zimmer *et al.* 1994) has been shown to correlate with awareness of, and concern with, environmental concerns. With the exception of Hounshell and Liggett (1973), these studies have generally found a positive correlation between architects practising in urban/suburban areas versus small towns or rural areas and their likelihood to have environmental concerns. Survey respondents were asked to identify the type of location where they conducted the majority of their business: 1) urban/suburban (populations greater than 50 000), 2) small town, (areas isolated from major urban areas with a population less than 50 000), or 3) rural, (low density population scattered over a wide area). The vast majority of survey respondents (over 79%) reported that they worked mainly in urban/suburban areas, with just 15.8% working in small towns, and 5.3% working in rural areas. This result has a higher percentage of respondents in

Table 1. Respondent firm or individual experience

Years in business	% of respondents
0–9	11.2%
10–19	18.8%
20–29	35.4%
30–39	23.9%
40–49	8.8%
50–60	2.0%

Table 2. Options for architects to rank reasons for environmentally certified wood product usage

Rank top three reasons: Why I have not used FSC- or SFI-certified wood	FSC	SFI	Rank top three reasons: Why I have used FSC- or SFI-certified wood	FSC	SFI
Never felt the need	14.2%	13.7%	Customer Demand	14.0%	9.8%
Not readily available	11.9%	16.4%	Reliable availability	8.1%	7.4%
Cost not justified from business standpoint	20.2%	15.0%	It is an integral part of my construction design/practice	11.4%	16.5%
No customer demand	36.9%	32.7%	Contributes significantly to green building points	16.1%	17.3%
Not enough green building points	2.6%	3.8%	I believe the environmental benefits are substantial	30.4%	28.7%
I have plans to start using it in the near future	5.2%	3.1%	Helps differentiate my homes from competitors	3.9%	4.6%
I do not believe the environmental benefits are substantial	6.3%	9.0%	Increases profitability of my homes	0.9%	0.1%
Other (specify)	2.6%	6.2%	Increases greener image of my company	10.7%	10.5%
–	–	–	Other (specify)	4.5%	5.1%

urban areas compared to a similar study by Ganguly *et al.* (2013) measuring home builder location. Their research showed that 58% of home builders were located in urban areas, with 29% in small towns, and 13% in rural areas, respectively, suggesting that architects are not necessarily located in the areas where the homes they design are being built. Alternatively, it suggests that builders and home buyers in rural areas and small towns are significantly less likely to use architects to design their homes.

Awareness and use of environmentally certified wood products

Survey respondents were asked to provide information on their awareness and usage of ECWPs (Fig. 1). Most architects reported that they were aware of ECWPs, with over 50% of architects having specified FSC-certified wood, but just 25% had specified SFI-certified wood. More importantly, almost a quarter of respondents had never heard of SFI-certified wood (23.3%) as compared to just 13.1% for FSC-certified wood.

To get a better understanding of the factors that influence architects' use of ECWPs, respondents who do not use ECWPs were asked to provide more information on why they do not use them. Architects' top reasons for not using FSC-certified wood were: 1) no customer demand (36.9%), 2) cost not justified (20.2%), and 3) never felt the need (14.2%). Their top three reasons for not using SFI-certified wood were: 1) no customer demand (32.7%), 2) not readily available (16.4%), and 3) cost not justified (15.0%). The top two reasons that respondents gave for using certified wood were the same for both FSC and SFI wood: 1) the environmental benefits are substantial (30.4% FSC, 28.7% SFI), 2) it contributes significantly to green building points (16.1% FSC,17.3% SFI). The third reason was different for FSC and SFI: customer demand (FSC 14.0%), and integral part of construction practice (SFI 16.5%). The available options are listed in Table 2.

Awareness and use of LEED for Homes and NGBS

Another component of the project looked at evaluating architect's awareness and use of residential green building programs. Respondents were asked to report on their familiarity with both the LEED for Homes green building program as well as the NGBS program (Fig. 2). Over 99% of architects indicated that they were aware of the LEED for Homes programs compared to 83% awareness of the NGBS programs. While less than 1% of respondents had not heard of the LEED for Homes program almost 17% had not heard of the NGBS program. There was a large difference in usage between the two programs with 23.3% of respondents having used the LEED for Home program relative to just 6.9%

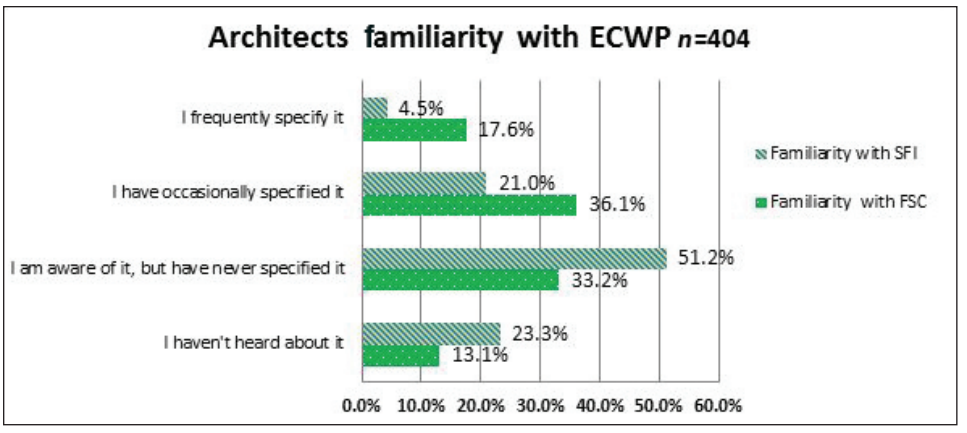

Fig. 1. Architects' awareness and usage of environmentally certified wood products.

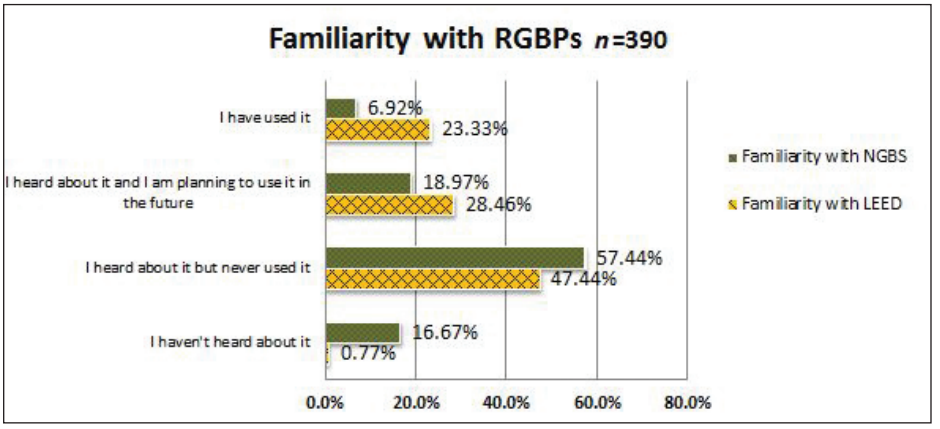

Fig. 2. Architects' awareness and usage of residential green building programs.

usage for the NGBS program. Similarly, 28.5% of respondents reported that they planned on using the LEED for Homes program in than future compared to 19% for the NGBS program.

Irrespective of their past experience with RGBPs, survey participants were asked to identify the top three reasons they had or had not participated in the different RGBPs (Table 3). When asked to identify their top reasons for not using LEED for Homes, architects listed their reasons as: 1) homebuyers are not willing to pay a premium (23.4%), 2) documentation process too complicated (21.0%), and 3) no market demand (20.9%). The ordering was different for NGBS with 1) no market demand (31.3%), 2) homebuyers are not willing to pay a premium (23.1%), and the number-three-rated reason was "do not have necessary training to get certified" (15.5%).

Survey respondents were also asked to rank their top three reasons for using each green building program (Table 3). Based on their survey responses, the top reasons for using LEED for Homes were: 1) it helps differentiate my homes (29.3%), 2) the homeowner specified that we use the program (25.2%), and 3) there is strong demand for green homes (21.6%). When providing their top reasons for using the NGBS program, the number 1 reason was unchanged (28.0%) but the number 2 reason was the documentation process is straightforward (18.8%), and number 3 was "strong demand for green homes" (16.3%).

Material selection attributes

For structural wood products, Wagner and Hansen (2004) found that material availability and uniform quality were rated by architects as being the most important product attributes, with durability and environmental sustainability being ranked third and fourth. Damery and Fisette (2001) surveyed architects, contractors, and homeowners regarding their preferences on home siding. Their results found a preference for product attributes that were weighted toward appearance and performance as opposed to cost and personal recommendations. Knowles *et al.* (2011) found that architects use a different process for the selection of a structural system for a building versus the decision to improve the environmental performance of a structure. Architects' have the difficult decision of selecting materials that meet both their design requirements and local building codes while trying to keep costs down and integrating environmentally friendly building materials into the design.

In this survey, architects were asked to rate the importance of a wide variety of material attributes using a Likert scale where a score of 1 = not at all important, a score of 3 = neutral and a score of 5 meant that the attribute was considered to be very important. As shown in Fig. 3, all the product attributes received a mean rating higher than 3 and were of some importance in their decision-making, except for CO_2 emissions during manufacturing ($p = 0.09$), which was not significantly different from

Table 3. Options for architect to rank reasons of residential green building program usage

Rank top three reasons: Why I have not used green building programs	LEED	NGBS	Rank top three reasons: Why I have used green building programs	LEED	NGBS
No market demand for certified houses under the program	20.9%	31.3%	Strong demand for green houses certified under this program	21.6%	16.3%
Homebuyers are not willing to pay a premium for a green house	23.4%	23.1%	It helps differentiate my homes on the market	29.3%	28.0%
It is too expensive to get homes certified under this program	20.0%	9.2%	Increases profitability of my homes	3.2%	2.4%
The documentation process is too complicated	21.0%	8.5%	Documentation process is straightforward	5.4%	18.8%
Green building products are too difficult to obtain	1.6%	1.7%	Homeowner specified the program	25.2%	12.6%
We do not have the necessary training to get certified under this program	7.3%	15.5%	Builder specified the program	6.6%	5.7%
Other (specify	5.7%	10.8%	Other (specify)	8.7%	16.3%

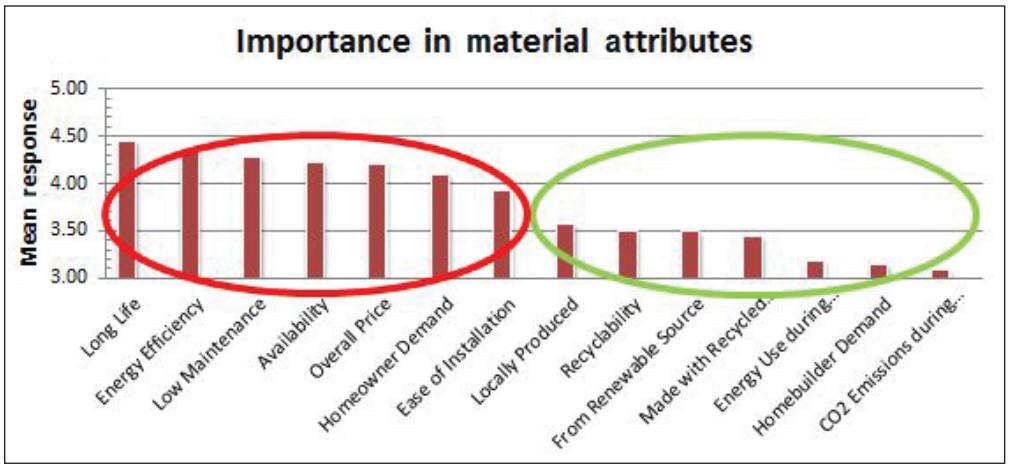

Fig. 3. Architects' mean response for importance of attributes in material selection.

neutral = 3 at the 0.05 level of significance. The highest-rated attribute was long life of the material, with energy efficiency and low maintenance also being highly rated. These attributes are considered to be functional in nature because they pertain to the performance of the home. The next three attributes—availability, overall price and homeowner demand—were more economically oriented. There appeared to be two distinct groupings in the selection of attributes. The first seven attributes pertained to functional or economic traits of material selection. The second grouping largely pertained to the environmental attributes of a building material. Homebuilder demand was the only attribute that did not appear to belong in this second grouping of attributes.

Test of independence

To test if specific demographic variables were related to architects' usage of ECWPs, a chi-square test of independence was performed. The statistical analysis was performed to see if either geographic location (urban, small town, rural) or years in business were significant indicators of architects usage of FSC- or SFI-certified wood. Geographic location (urban areas) was slightly significant (p <0.10) as an indicator of the usage of ECWPs (both FSC and SFI); years in business was not found to be statistically significant.

Since an architect's participation in a green building program could be a driver of ECWP usage, a chi-square test of independence was performed for the two questions of ECWP and RGBP awareness and usage. This statistical analysis would indicate if architects who had responded that they participated in RGBPs would be more likely to have used certified wood. The likelihood of using both FSC- and SFI-certified wood were both highly significant (p <0.001) for architects who indicated that they had used the LEED for Homes program. This result is counterintuitive, since the LEED for Home program only awards green building points for the use of FSC-certified wood. Most likely, this result is suggestive of the fact that many survey respondents indicated that they had used SFI regardless if it was for a LEED for Homes project or not.

For architects who had used the NGBS program, only the usage of SFI was significant at the p <0.001 level. Participation in the NGBS program was not a significant indicator of increased usage of FSC-certified wood. This result makes sense since the NGBP program allows the usage of all third-party certified wood to qualify for green building points and architects are not constrained to using only FSC-certified wood as they are with the LEED for Home program.

Conclusions

Residential architects are fairly homogenous in regards to their demographic profile, so the market orientation of architects (economic, functional, or environmental) might be a better indicator of their potential for using ECWPs. As the results show, architects still base a large part of their material decisions on the economic and functional attributes of materials. Residential homes sales often have small profit margins, so the additional costs of using environmentally friendly materials can be hard to justify to potential home buyers. FSC-certified wood is perceived by architects as being more expensive than SFI-certified wood whereas SFI-certified wood still struggles against the perception that it is not as environmentally friendly as FSC-certified wood. However, wood certified under both certification programs continues to be perceived as being difficult to source in the marketplace, which could hinder their usage in the short term.

Products produced under both sustainable certification standards benefit from their eco-labels since they are perceived as being produced from sustainably managed forests. In addition, ECWPs are perceived as being a relatively easy way to generate points with RGBPs. Many architects perceive customer demand and the use of certified wood products as an integral part of their design practice and, as a result, more architects may incorporate ECWPs into their home designs in the future.

While more architects have used FSC-certified wood and the LEED for Homes program, most have also heard of SFI-certified wood and the NGBS program. Although the NGBS program may currently lag behind the LEED for Homes program, many architects that have used the program see an inherent benefit in the reduced amount of paperwork required to gain certification and this could prove to be a competitive advantage for the NGBS program. The NAHB may need to help architects in getting certified or at least provide additional materials to make it easier for them to learn about the program. As an overall benefit, architects believe that RGBPs differentiate their homes and this should bode well for green building programs going forward.

The adoption of a residential green building program strongly influences architects' usage of environmentally certified wood products. This was found to be true of LEED for Homes with FSC- and SFI-certified wood as well as for the NGBS program and SFI-certified wood. Based on the large difference in the area of forests certified under the two certification programs, SFI-certified wood should be more readily available in the marketplace. As more architects become adopters of the RGBPs, and the area of SFI-certified forests continues to grow, this difference could become significant.

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