Environmentally Certified Wood Use by Green Builders and Traditional Builders

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Abstract

The residential construction sector (consisting of both new home construction and repair and remodel activity) is the largest end use market for softwood lumber in the U.S. and has a substantial impact on the usage of environmentally certified wood products (ECWP). Residential green building programs (RGBPs) integrate eco-friendly materials in the design and construction of homes to reduce energy consumption and environmental impact. Residential buildings are a major source of CO₂ emissions and use more energy than any other area of the building sector. The green home building market is growing, which presents an opportunity for certified wood use in the residential construction market.

This study investigates the awareness and use of environmentally certified wood products by green and traditional builders in the U.S. residential construction sector. The use of environmentally certified wood products in residential construction projects is not required to receive an eco-label from an RGBP therefore it is important to understand the factors influencing a homebuilders decision to use ECWPs. Understanding the differences between green and traditional builders allows conclusions to be formed on how to most effectively encourage the use of ECWP in the U.S. residential construction market.

Data was analyzed from 500 survey respondents. The results of this study indicate green and traditional builders have significantly different levels of awareness and use of ECWPs. The data indicated significant differences between green and traditional builders when separated by census regions and firm size. Builders reported their main reasons for using and not using RGBPs and ECWPs revealing differences between green and traditional builders in their use of these programs. Significant differences were reported between green and traditional builders in their rating of the importance of environmental attributes in their selection of building materials. Comparison of the environmental impact of wood relative to steel and concrete indicate both builder groups consider wood to be more environmentally friendly on a majority of the attributes and both builder groups reported a positive rating for wood on all of the attributes considered in the study.
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Introduction

Third party forest certification systems are non-state market driven programs developed to recognize well-managed sustainable utilization of forestlands (Bernstein & Cashore, 2003). Forest certification systems evaluate firm performance based on social, environmental, and economic criteria through third party independent assessment of forestry management practices to provide assurance to consumers that firms who receive certification meet or exceed minimum certification standards (Moore, Cubbage, & Eicheldinger, 2012). Incentives for certification include perceived price premiums, promotion of an environmentally responsible image, and market access (Espinoza, Buehlmann, & Smith, 2012; Chen, Innes & Takina, 2010). Through forest certification and chain-of-custody (CoC) tracking, third party verified wood certification programs such as the Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) provide consumers with the ability to verify that forest products originated from sustainably managed forests (Vidal, Kozak, & Cohen, 2005).

As the largest end-use market for softwood lumber in the U.S., the residential construction sector (consisting of both new home construction and repair and remodel activity) has a substantial impact on the usage of environmentally certified wood products (ECWP). In 2015, the residential construction sector consumed approximately two-thirds of all softwood lumber in the U.S. (WWPA, 2015). Factors driving the use of certified wood by home builders include promotion of an environmentally conscious image, concern for the environment, and green building codes (Ganguly, Eastin & Rabotyagov, 2008). The projected increase in green home construction and renovation projects presents an opportunity for environmentally certified wood in the residential construction sector (Estep, DeVallance & Grushecky, 2013).

Residential green building programs (RGBPs) integrate eco-friendly materials in the design and construction of homes to reduce energy consumption and environmental impact. Residential buildings are a major source of CO₂ emissions, consume more energy than any other area of the building sector (Estiri, 2015), and account for over 20% of total energy consumption in the U.S. (U.S. DoE, 2011). Despite growing awareness of green building, debate exists around its definition and it is alternatively referred to as high performance building and sustainable building (Zuo & Zhao, 2014). Interest in green building programs across the U.S. has been steadily increasing (Eicholtz et al, 2013), and green homes have been projected to have a 29% - 38% market share of new home construction by 2016, up from 17% in 2011 (McGraw-Hill, 2012).

The U.S. Green Building Councils’ Leadership in Energy and Environmental Design (LEED for Homes) and the National Association of Home Builders’ ICC-700-National Green Building Standard (NGBS) award points for the use of eco-friendly materials in home construction projects including the use of environmentally certified wood products. LEED for Homes only awards points for the use of Forest Stewardship Council (FSC) certified wood. The NGBS recognizes all credible third party certified wood programs, which include, FSC, Sustainable Forestry Initiative (SFI), Programme for the Endorsement of Forest Certification (PEFC), and the American Tree Farm System (ATFS). Using environmentally certified wood in a home adds to the total number of points awarded for the project, although it is possible to receive an eco-label from an RGBP without the use of environmentally certified wood. RGBPs have increased the market for ECWPs because home builders are able receive points for using certified wood in framing and structural elements of a home whereas traditionally most wood from certified forests were used in value-added products (Bowers, Ganguly, & Eastin, 2014). As of late 2015, in North America,
there were 67,253,028 ha of FSC certified forests (FSC, 2015) and there were 156,793,659 ha of PEFC certified forests (PEFC, 2015). PEFC is a global umbrella organization that endorses national and regional certification systems, such as Sustainable Forestry Initiative (SFI), American Tree Farm System (ATFS), and Canadian Standards Association (CSA) that have proven compliance with PEFCs guidelines and criteria (PEFC b).

The growing interest and use of RGBPs provides an incentive for homebuilders to incorporate ECWPs in their construction projects. The two leading RGBPs in the U.S., LEED for Homes and NGBS, do not require the use of ECWPs to receive an eco-label certification therefore it is useful to understand the factors affecting the usage of ECWPs in residential home construction projects among green and traditional builders. Understanding the differences between green and traditional builders in their perceptions of building materials, building product environmental attributes, and awareness and use of ECWPs is important for sustainable forest management and reducing the environmental impact of the residential construction sector.

**Literature Review**

**Summary of Body of Knowledge of Certification Programs**

Forest certification is a non-governmental market based mechanism that aims to promote sustainable forest management. Forest certification was developed to address public concerns in the 1980s about biodiversity loss and tropical deforestation (Rametsteiner & Simula, 2003). Perceived ineffectiveness of inter-governmental organizations in developing programs to promote sustainable forest management prompted environmental NGOs, retailers, and producers to create the first forest certification programs in the early 1990s (Klooster, 2005). Public campaigns, boycotts, and bans on tropical wood products, initially supported by environmental NGOs, were replaced by forest certification as a voluntary market based approach to creating incentives for producers to engage in environmentally responsible and sustainable forestry (Nussbaum & Simula, 2005).

The Forest Stewardship Council (FSC), was founded in 1993 by suppliers, retailers, and environmental organizations with 130 participants from 26 countries representing a wide variety of social, environmental, and economic interests (Klooster, 2005). FSC is governed by a tripartite system consisting of a social, environmental, and economic chamber, each with equal voting rights to prevent any one chamber from dominating the rule making process (Auld, Gulbrandsen, McDermott, 2008). FSC currently operates in 80 countries. As of early 2016, there were 67,038,964 ha of FSC certified forests in North America, representing 36% of all FSC certified area globally. FSC has issued 3,815 chain-of-custody certificates and 243 forest management certificates in North America (FSC, 2016). Through forest management and chain-of-custody certification FSC tracks certified products through the supply chain from forest to end consumer. Research has indicated a constrained supply of FSC wood in some areas, in addition to a limited number of FSC certified processors may influence a builders’ decision to seek points for using certified wood in green building projects (Germain & Penfield, 2010).

Founded in 1999, PEFC is a global umbrella organization that endorses national and regional certification systems, such as the Sustainable Forestry Initiative (SFI), the American Tree Farm System (ATFS), and the Canadian Standards Association (CSA), that have proven compliance with PEFCs guidelines and criteria (PEFC b, 2015). As of late 2015, in North America there were 156,793,659 ha of PEFC certified forests representing 59% of total PEFC certified area globally. PEFC has issued 441 chain-of-custody certificates.
in North America (PEFC a, 2015). PEFC and FSC are considered the most prominent forest certification programs globally with just under 450 million ha of forests certified to their standards. In North America, certified forests supplied an estimated 13.9% of total round wood production in 2015. Forest certification globally continues to grow, albeit more slowly in recent years (FAO, 2015).

The American Forest and Paper Association developed the Sustainable Forestry Initiative (SFI) in 1994 to promote sustainable forest management through principles valuing social, economic, and environmental interests. SFI has certifications for forest management, fiber sourcing, and chain-of-custody tracking. SFI operates under an 18-member board with equal representation from social, environmental, and economic sectors. SFI is internationally endorsed by PEFC and therefore recognizes all PEFC endorsed programs in their chain-of-custody certifications. SFI, by area, is the largest single certification program, with more than 100 million ha of forests certified in Canada and the U.S. (SFI).

FSC and SFI are the two leading forest certification programs operating in the U.S. FSC and SFI both promote sustainable forest management yet differences exist between the programs (Rametsteiner & Simula, 2003). Previous studies have suggested each program has different strengths and weaknesses, which may reflect the differing origins of the programs (Sample, Price & Mater, 2003). Firms seeking certification undergo an independent assessment of their forest management practices from an accredited certification body to determine their readiness to receive certification. Forest management practices are evaluated in relation to the predefined standards of the certification program. Generally, certification standards address a broad array of social, environmental, and economic practices (Moore, Cubbage & Eicheldinger, 2010). An independent audit confirms the certification standards have been achieved resulting in the initial forest management certification which must be renewed on a regular basis.

Forest certification operates as a market based incentive program based partially on the perception that consumers will pay a premium for environmentally certified products, yet research indicates substantial price premiums have not materialized for certified products (Tippura, Toppinen & Puumalainen, 2015; Marx & Cuypers, 2010; Van Kooten, Nelson & Vertinsky, 2005). It is also not clear that when a premium has been achieved that other influences such as limited supply were not contributing factors (Gullison, 2003). Previous studies have reported a wide variability in a consumers’ willingness to pay (WTP) for certified wood products (Cai & Aguilar, 2013). Ozanne and Vlosky (2003) reported average willingness to pay for certified wood items including a 2x4 stud, RTA chair, and new home on average decreased from 1995 – 2000. Cai and Aguilar (2013) report an increase in consumers WTP from meta-analysis of survey responses conducted between 1995-1999 and 2000-2004, while noting that the structure of a survey question, such as the amount of product detail provided, may influence the responses. A substantial amount of research has demonstrated inconsistent behavior by consumers in their willingness to pay for green products (Forrer & Mo, 2013).

Despite the widespread acceptance and proliferation of certification programs (Auld, Gulbrandsen, & McDermott, 2008) little is known about their effectiveness in achieving sustainable forest management (Clark & Kozar, 2011). Consumer awareness of certification programs has increased since their introduction but consumers have also questioned the effectiveness of forest certification in halting tropical deforestation (Ozanne & Vlosky, 2003). Roughly 10% of global forests are certified (Tippura, Toppinen & Puumalainen, 2015) and these forests are predominantly located in the global north with approximately 90% of certified forests located in the northern hemisphere (FAO, 2015). Studies have
suggested the costs of certification are prohibitively high for many forest owners in developing countries where cost can vary substantially depending on operation size and forest complexity (Marx & Cuypers, 2010).

Previous studies have indicated exporting forest products to Europe and North America influences a firms’ decision to certify to retain access to those markets (Auld, Gulbrandsen, & McDermott, 2008). A large portion of tropical wood is consumed domestically (Forrer & Mo, 2013) and tropical timber exports predominantly go to Asia (Gullison, 2003), where forest certification programs have not been widely adopted (Bowers et al. 2012). Furthermore, research has raised questions about the viability of sustainable logging in the tropics given the complex forests, extended recovery times, poor enforcement of environmental regulations, and questionable dedication to long term sustainability of large multinational timber companies operating in forest countries (Shearman, Bryan & Laurance, 2012).

Research suggests that FSC and SFI have contributed to improving the social, economic, and environmental aspects of sustainable forestry with both systems requiring changes in a firms’ management activities in order to obtain certification (Moore, Cubbage & Eicheldinger, 2012). Although doubt has been raised over the level of trust consumers have in industry sponsored certification programs (Ozanne & Vlosky, 2003). A comparison of certification audits in Canada by Masters, Tikina, and Larson (2010) found FSC requested significantly more conditions that needed changing before certification could take place. A substantial amount of research has highlighted positive impacts of forest certification globally on forest governance (Forrer & Mo, 2013).

**Discussion of U.S. Residential Construction Sector, Green Building Programs, and ECWPs in Green Building Programs**

The two most prominent residential green building programs in the U.S. are the National Association of Home Builders (NAHB) ICC-700-National Green Building Standard (NGBS) launched in 2007 and the U.S. Green Building Councils Leadership in Energy and Environmental Design (LEED for Homes) launched in 2008. LEED for Homes and NGBS assign point values for the incorporation of predefined green practices in home construction projects. NGBS certifies projects at the bronze, silver, gold, and emerald level depending on the number of green practices incorporated in the design and construction of the building. LEED offers four certification levels: certified, silver, gold, and platinum (USGBC a, 2016). Research has shown a significant price difference between the LEED for Homes and NGBS program in total cost of building a green home. The additional cost for building a LEED for Homes certified green home is $7,450 compared to $2,650 for NGBS (Reposa, 2009).

Both certification systems use third party verification to ensure adherence to and proper implementation of green building standards. There are approximately 68,690 NGBS green certified homes (NAHB b, 2016) and 53,554 LEED for Homes certified units (USGBC, 2014). NGBS emphasizes lot design and development, water efficiency, energy conservation, resource conservation, indoor environmental quality, and homeowner education (NAHB a, 2016). NGBS awards points for the use of certified wood from all credible third-party-certified programs. LEED for Homes emphasizes the entire impact of the project from site selection, water efficiency, materials and resources, energy and atmosphere, indoor environmental quality, location and linkages, awareness and education, and innovation (USGBC b, 2016). In contrast to NGBS, LEED for Homes recognizes only FSC certified wood under the NC 2009 rating system, Materials and Resources credit category, MRc7 credit, which awards 1 point if 50% of wood (by cost) in a home construction project is FSC certified, with the potential for an
extra point for exemplary performance when using 95% or more FSC certified wood (LEED a). Additional points, under the MRc5 credit are available for using regionally sourced material, defined as being from within 500 miles of the building site for both extraction and manufacturing distance with a prorated calculation for water and rail shipping (LEED b).

**Objective**

This study was conducted to gain a better understanding of U.S. residential builders’ awareness and use of environmentally certified wood products (ECWPs), forest certification programs, and the environmental performance of wood as a building material relative to steel and concrete.

This study seeks to address the following questions: a) how do green builders differ from traditional builders in general; b) how do green builders differ from traditional builders in their awareness and use of Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) environmentally certified wood.

**Survey Methodology and Data Collection**

A web-based survey instrument was used to collect information from respondents within our survey segment. The survey was powered by Qualtrics (Qualtrics Labs, Inc., version 2011), a web based survey software. Logical sequencing was used in the survey design allowing respondents to answer only questions that applied to them; enabling a progressive profiling of respondents. For example, only builders who were aware of and used FSC certified wood were allowed to report their main reasons for using it, while respondents who were unaware of FSC wood were allowed to report why they had not used it. The survey data was uploaded to SPSS-19 for conducting the statistical analysis.

**Sample Size Calculation**

The survey was designed to analyze two populations i) the whole U.S. residential construction industry (homebuilders and remodelers) and ii) homebuilder which have used LEED for Homes or NGBS.

**Phase i) Sample Size for Whole U.S. Residential Construction Industry**

The following formula was used to estimate a sample size from the target population based on specified confidence level and presumed awareness level (Krejcie & Morgan, 1970).

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

Equation 1

Where \( n \) = required sample size; \( N \) = target population size; \( P \) = the estimated value for the proportion of a sample who are aware of ECWPs; \( d \) = acceptable margin of error for the estimated value of \( p \); \( \chi^2 \) = value for chi-square for one degree of freedom relative to the desired level of confidence, (1-\( d \)).

Based on the sample size determined in the previous formula, the following implicit assumptions are made for the first survey segment:
1. The residential construction industry in the U.S. was assumed to be comprised of 211,647 homebuilders (N), including residential and non-residential homebuilders and home remodelers (U.S. Census, 2004).

2. Due to varied and unknown levels of awareness regarding different construction materials, a value of .5 (50%) is used for p since this will give the highest required sample size for the desired accuracy level (Cochran, 1977).

3. The acceptable margin of error is suggested to be 5% for categorical data (Krejcie & Morgan, 1970); although an error level 10% (or less) is acceptable for social science research (Bartlett et al., 2001). For this study, 5% was used as the acceptable margin of error value (d).

Based on the aforesaid assumptions, the corresponding \( \chi^2 \) value for one degree of freedom was calculated to be 3.84. Using Equation 1 and the pre-stated assumptions, the minimum sample size was calculated to be 383.5. For convenience, the sample size was set at 400 usable survey responses.

**Phase ii) Sample Size for Green Builders**

The target population of green builders was conservatively estimated to be, N=8,500, 90% are assumed to be aware of environmentally certified wood products, therefore, .9 is used for P. Using equation 1, the minimum sample size for green builders was calculated to be 136.1.

**Data Collection**

The National Association of Home Builders (NAHB) maintains the largest active web based panel of residential homebuilders and remodelers in the U.S. covering all 50 states and all firm sizes. A sample frame of 2,000 homebuilders and remodelers was selected using standard random sampling techniques based on a random number generator. The target response rate was estimated to be 20% ensuring that 400 completed surveys would be collected. An email containing a link to the questionnaire was sent to the randomly selected homebuilders and remodelers. Weekly reminders were sent to non-respondents. The email link was disabled after reaching the target response rate of 400 surveys one month after initiating the survey. A total of 494 responses were received.

The green builder sampling ensures satisfactory representation of builders who had used a residential green building program in the survey respondents. The Phase-2 sampling of registered green builders was conducted during October 2011. A publicly available list of builders registered with NGBS and LEED for Homes was used to obtain the email addresses of 1,010 builders. A link to the web-based survey was sent to the email addresses and phone calls asking them to participate were used to increase the response rate.

The phase-2 green builder respondents were combined with the builders from phase-1 who had participated in a residential green building program to establish the green builder sample for this study. Phase-2 green builders and phase-1 home builders that had participated in a residential green building program will hence forth in this study be referred to as green builders. A total of 494 respondents were collected from phase-1 and 182 respondents from phase-2.

Limitations associated with conducting online surveys are well documented (Wright, 2005). Self-selection bias is a limitation associated with this study because certain groups of people may not be willing to respond to an email invitation to participate in a web based survey. The data presented in this
study was collected within several years of the 2008 economic recession and therefore responses may have been influenced by the downturn in the residential housing market. To be considered a green builder for the purposes of this study a builder had to participate in at least 1 residential green building project, therefore this study may include green builders that are not as committed to green building as those that have completed more green building projects.

Results and Discussion

This study is based on the phase-1 494 respondents from the survey of residential home builders and remodelers and the phase-2 survey of 182 green builders. Respondents were identified as green builders or traditional builders. Builders who had completed at least 1 residential construction project with a green building program, were categorized as green builders. Traditional builders, for the purposes of this study, are residential home builders and remodelers who have not participated in any residential green building program. All of the phase-2 eco-builder respondents were counted as green builders because these builders had been identified as participating in residential green building programs. The 494 phase-1 respondents of the builder survey and the 182 phase-2 green builder surveys were filtered by eliminating surveys that were not complete and eliminating respondents who had not completed at least one homebuilding project in 2010. This process reduced our phase-1 builder survey respondents from 494 to 399 and our phase-2 green builder respondents from 182 to 101.

Demographic Characteristics of the Respondents

From the 500 respondents, 227 were green builders and 273 were traditional builders. Of the green builders, 89% were homebuilders and 11% remodelers. Among traditional builders 72% were homebuilders and 28% were remodelers. A chi-square test of independence was conducted to determine if there was a statistically significant relationship between green and traditional builders and their nature of business. The difference in nature of business was statistically significant (p<.05) with green builders significantly more likely to be homebuilders and remodelers significantly more likely to be traditional builders.

The area where firms conducted business was evaluated in the survey. Green builders conducted 60% of their business in urban / suburban areas, 25% in small towns, and 15% in rural areas. Traditional builders conducted 56% of their business in urban / suburban areas, 31% in small towns, and 13% in rural areas. Statistical analysis demonstrated no significant differences between green builders and traditional builders in their area of operation.

The respondents in this survey represented residential construction professionals from the four U.S. census regions, West, Midwest, South, and Northeast. The Northeast region had a higher proportion of traditional builders (23%) than green builders (17%) and the Midwest had a higher proportion of traditional builders (30%) over green builders (22%). The south had a larger proportion of green builders (38%) compared to traditional builders (30%).The west had a higher proportion of green builders (24%) than traditional builders (16%). Statistical analysis conducted with a chi-square test of independence indicated a statistically significant (p<.05) association between census regions and green and traditional builders (Pearson chi-square value = 11.995, d.f. = 3, p value = .007). A comparison of column proportions using a Bonferroni correction for multiple comparisons indicated the West census region had a significantly higher (p<.05) proportion of green builders than traditional builders. The Midwest region had a significantly higher proportion of traditional builders than green builders.
The dataset represented homebuilders from a wide variety of firm sizes. As is common practice in construction literature, annual revenue is used as a proxy for firm size. In this study, homebuilders were segmented into three main revenue groups, small firms had annual revenue under $500,000, medium firms had revenue between $500,001 and $3 million and large firms had revenue over $3 million (figure 1).

![Green and Traditional Builders 2010 Revenue](image)

**Fig. 1.** Breakdown of green and traditional builders based on reported 2010 revenue.
Green Building Program Awareness and Use

Respondents were asked to report their awareness and use of the LEED for Homes and NGBS green building programs. The data indicates green builders favor NGBS over LEED with 60% of green builders reporting they had used NGBS while 39% had used LEED. Among traditional builders, 28% reported they had heard of and were planning on using LEED in the future while 35% reported the same for NGBS.

Test of Independence

To test if awareness of LEED and NGBS is independent of being a green or traditional builder a chi-square test of independence was conducted. Traditional builders are builders who had not used a RGBP therefore these builders would not be present in the awareness category, have used it, this column was excluded from the chi-square test. The chi-square test results only applies to the first three levels of awareness, haven’t heard about it, heard about it but have never used it, heard about it and I am planning to use it in the future. The test results were statistically significant for LEED between green and traditional builders (Figure 2).

Green and Traditional Builders Main Reasons for Use / Non Use of LEED and NGBS

The survey respondents were asked to rank their top three reasons for using or planning to use and not using LEED and NGBS green building programs. A composite weighted average score was calculated for the responses by assigning 5 points to the top ranked reason, 3 points for the second ranked reason, and 1 point for the third ranked reason.
Main Reasons for Using or planning to Use LEED and NGBS

Green and traditional builders reported the same three main reasons for using or planning to use LEED, 1) it helps differentiate my homes in the market, 2) consumer specified the program, 3) strong demand for green houses certified under this program. It is interesting to note green and traditional builders included the straight forward documentation process in their main reasons for using NGBS, this stands in contrast to the low ranking for LEED on this reason which suggests it is an important reason that builders use NGBS. The results indicate the importance of green building programs in differentiating homes in the marketplace with all builders reporting this as the main reason for using a RGBP. The importance of consumers specifying the use of a RGBP appears to be substantial with this reason ranking highly across all groups.
The results indicate the cost of certification is important to builders when choosing a certification program. The cost of certifying with LEED was reported to be among the most important reasons for green builders in their decision not to use the program. In contrast, NGBS ranked substantially lower for the cost of certification among green builders as a reason for not using the program. These results align with previous research which demonstrated the cost of building a green home under the LEED program was significantly more expensive than NGBS. In addition to certification costs, traditional builders were not using LEED and NGBS because they believed there was no market demand for certified homes and they felt home buyers were not willing to pay a premium for certification.
Awareness and Use of Environmentally Certified Wood

FSC and SFI Awareness and Use

Survey respondents were asked to provide information about their awareness and use of FSC and SFI certified wood. Over 50% of green builders were frequent or occasional users of certified wood. Whereas about 20% of traditional builders were frequent or occasional users. Over 40% of traditional builders had never heard of either FSC or SFI wood.

Fig. 5. Awareness and Use of Certified Wood.

FSC: Green and traditional builders crosstab Pearson Chi Square value = 106.506, d.f. = 3, p<.000
SFI: Green and Traditional Builders crosstab Pearson Chi Square value = 58.899, d.f. = 3, p<.000

Test of Independence

To test if a statistically significant relationship exists between green and traditional builders and certified wood use statistical analysis using a chi square test of independence and a comparison of column proportions using the Bonferonni correction for multiple comparisons was conducted. Results demonstrated green builders were significantly more likely (p<.05) to be frequent users (24%) and occasional users (37%) of FSC certified wood. Traditional builders were significantly more likely to have never heard of FSC (47%) and be aware of FSC wood but never used it (34%). Green builders were significantly more likely to be frequent users (15%) and occasional users (37%) of SFI wood. Traditional
users were significantly more likely to have never heard of SFI wood (47%) and be aware of SFI wood but never used it (38.5%).

The results indicate that green builders were statistically significantly more likely to be frequent and occasional users of certified wood, even though green builders are not required to incorporate certified wood in their construction projects to attain a green certification. The data suggests green building programs contribute to the awareness and use of certified wood by homebuilders in the U.S.

**Main Reasons for Certified Wood use / non-use**

The survey respondents were asked to rank their top three reasons for using and not using FSC and SFI certified wood. A composite weighted average score was calculated for the responses by assigning 5 points to the top ranked reason, 3 points for the second ranked reason, and 1 point for the third ranked reason.

![Fig. 6. Main reasons for using FSC and SFI wood](image-url)
Main Reasons for Using FSC and SFI Certified Wood

It is interesting to note green builders ranked the contribution of FSC and SFI certified wood to green building points as the most important reason for using certified wood from both programs. This demonstrates the importance of green building programs in creating demand for certified wood. In contrast to the importance of green building points for green builders, for FSC wood traditional builders ranked environmental benefits and customer demand as important reasons for using FSC wood. Traditional builders ranked green image and reliable availability as important reasons for using SFI wood. Environmental benefits of FSC and SFI wood were ranked as one of the main reasons for traditional builders using both certified wood programs. The role of certified wood in increasing the profitability of homes was ranked as the least important reason for using FSC and SFI certified wood by green and traditional builders. The data indicates green and traditional builders chose to use environmentally certified wood for different reasons with traditional builders valuing customer demand and environmental benefits while green builders placed more value on promoting a green image and receiving green building points.
Main Reasons for Not Using FSC and SFI Certified Wood

Green and traditional builders ranked the same top three reasons for not using FSC and SFI certified wood. No customer demand was ranked as the most important reason by green and traditional builders for not using FSC and SFI wood. These results indicate the connection between consumer awareness of certified wood products and their use by homebuilders. The importance of justifying the cost of using certified wood in a building project is reflected in the results with this reason ranked in the top three reasons for green and traditional builders for SFI and FSC wood. It is interesting to note SFI ranked more highly in importance of not being readily available in choosing not to use certified wood. Most commonly in the literature it is constrained supply of FSC wood mentioned as a factor in its use by builders. Both builder groups indicated the level of green building points received for FSC and SFI wood was not an important factor in their decision to not use certified wood. The data suggests increasing the points builders receive for certified wood in RGBPs may only have a minimal effect on their use of certified wood. Instead, focusing on increasing customer demand and creating a premium for certified wood
wood use would be more successful strategies to increase the use of certified wood by green and traditional builders.

*Certified Wood Awareness by Firm Size*

![FSC Awareness by Revenue Groups](image)

**Fig. 8. FSC Awareness by Builder Revenue Groups**

Green builders and revenue groups crosstab Pearson Chi Square value = 8.141, d.f. = 6, p=.228

Traditional builders and revenue groups crosstab Pearson Chi Square value = 6.629, d.f. = 6, p=.356

A sizable difference exists between the awareness levels of FSC wood among green and traditional builders. Over half of the small and large traditional builders had never heard of FSC and over 40% for medium size firms. While over 60% of small and medium green builders have used FSC, either occasionally or frequently and over half of the large builders. Among green builders, frequent use of FSC tends to decrease as firm size increases although the difference was not statistically significant (figure 8).

**Test of Independence**

To test for a statistically significant relationship between awareness of certified wood by green and traditional builders and firm size a chi-square test of independence was conducted. The results show across all revenue groups green builders are significantly more likely (p<.05) to be frequent users of FSC
certified wood and traditional builders are significantly more likely to have not heard of FSC wood. The data indicates, across all revenue groups, green builders were associated with having a higher awareness of FSC certified wood. Data collected on awareness and use of SFI wood indicates similar results. Green builders across all revenue groups have a statistically significantly higher awareness of SFI certified wood than traditional builders.

**FSC Small:** Traditional builders were significantly more likely to have not heard of FSC wood. Green builders were significantly more likely to be occasional and frequent users of FSC wood. Pearson chi-square value = 35.029, d.f. = 3, p value = .000.

**FSC Medium:** Traditional builders were significantly more likely to have never heard of FSC and to be aware but never used FSC wood than green builders. Green builders were significantly more likely to be occasional and frequent users of FSC wood. Pearson chi-square value = 56.552, d.f. = 3, p value = .000.

**FSC Large:** Traditional builders were significantly more likely to have never heard of FSC wood. Green builders were significantly more likely to be occasional and frequent users. Pearson chi-square value = 17.168, d.f. = 3, p value = .001
Fig. 9. SFI Awareness by Builder Revenue Groups

Green builders and revenue groups Pearson chi-Square value = 8.545, d.f. = 6, p=.201

Traditional Builders and revenue Pearson chi-Square value = 2.891, d.f. = 6, p=.822

**SFI Small:** Traditional builders were significantly more likely to have never heard of SFI wood. Green builders are significantly more likely to be occasional users of SFI wood. Pearson chi-square value = 10.311, d.f. = 3, p value = .016.

**SFI Medium:** Traditional builders were significantly more likely to have not heard of SFI wood. Green builders were significantly more likely to be occasional and frequent users of SFI wood. Pearson chi-square value = 36.657, d.f. = 3, p value = .000.

**SFI Large:** Green builders were significantly more likely to be occasional users of SFI wood. No other significant associations. Pearson chi-square value = 14.069, d.f. = 3, p value = .003.

(figure 5)
Survey respondents represented builders from the 4 census regions of the U.S. Previous studies have demonstrated home builders’ awareness of certified wood varies depending on geographic location (Ganguly, Eastin, Rabotyagov, 2008). Awareness of FSC certified wood was compared after green and traditional builders were segregated by census region. Over 50% of green builders in all regions were either frequent or occasional users of FSC certified wood. More than 70% of traditional builders in all regions had either not heard of FSC or heard of but never used it.
Test of Independence

A chi-square test of independence was conducted to determine if there was a significant (p<.05) relationship between green and traditional builders and their awareness and use of FSC certified wood by census region. Statistical analysis using chi-square tests with a comparison of column proportions using Bonferroni correction for multiple comparisons indicate significant associations between green builders and traditional builders within individual census regions. A chi-square test of independence between census regions and green builders indicated no statistically significant relationships. Similarly, traditional builders demonstrated no statistically significant relationships between regions (figure 6).

**Northeast:** Northeast traditional builders were significantly more likely to have not heard about FSC wood while green builders were significantly more likely to have occasionally and frequently used FSC wood. No significant difference between, I am aware but never used. Pearson chi square value 18.857, d.f.=3, p value = .000.

**Midwest:** Midwest traditional builders were significantly more likely to have not heard of FSC wood while green builders were significantly more likely to be frequent users of FSC wood. No other statistically significant associations in Midwest region. Pearson chi square value 31.219, d.f. = 3, p value = .000.

**South:** Southern traditional builders were significantly more likely to have not heard of FSC and to be aware but never used FSC. Southern green builders were significantly more likely to be occasional and frequent users of FSC wood. Pearson chi square value 45.976, d.f. = 3, p value =.000.

**West:** Traditional builders in the West region were significantly more likely to have never heard of FSC wood. Green builders in the West were significantly more likely to be occasional users. Comparison of column proportion could not be done for frequent users because there are 0 frequent users for traditional builders but this assumed to be significant. Pearson chi square value 15.795, d.f. = 3, p value =.001.

The data indicates across all census regions traditional builders are significantly more likely to have never heard of FSC certified wood. Green builders were significantly more likely to be frequent users of FSC certified wood. The data suggest that RGBPs have a considerable influence on the awareness and usage of FSC certified wood across the U.S.
**SFI Certified Wood Awareness and Use**

**Fig. 11. SFI Awareness by Census Region**

*Green Builders by census region Pearson chi-Square value = 9.935, d.f. = 9, p=.356*

*Traditional Builders by census region Pearson chi-Square value = 10.421, d.f. = 9, p=.317*

**Test of Independence**

Statistical analysis was conducted using a chi-square test of independence with a comparison of column proportions using Bonferroni correction to indicate significant associations (p<.05) between green and traditional builders within census regions. A chi-square test of independence between green builders and census regions indicated no statistically significant associations. Similarly, statistical analysis between traditional builders and census regions showed no statistically significant associations (figure 7).

**Northeast**: Traditional builders in the Northeast were significantly more likely to have not heard of SFI wood. Green builders were significantly more likely to be occasional users of SFI wood. No other significant associations for the region. Pearson chi square value 18.857, d.f. =3, p value = .000.
Midwest: Midwest traditional builders were significantly more likely to have not heard of SFI wood. Green builders are significantly more likely to be frequent users of SFI wood. No other significant association for the region. Pearson chi square value = 31.219, d.f. = 3, p value = .000.

South: Traditional builders in South region were significantly more likely to have never heard of SFI wood while green builders were significantly more likely to be occasional users of SFI wood. Pearson chi square value 45.976, d.f. = 3, p value = .000.

West: Traditional builders in the West were significantly more likely to be aware but have never used SFI wood. Green builders are significantly more likely to be occasional users of SFI wood. No responses for traditional builders for frequent users so no column proportion was compared but assumed to be significant. Pearson chi square value 15.795, d.f. 3, p value = .001.

The data indicates that across all census regions green builders were more likely to be occasional and frequent users of SFI certified wood. It is noteworthy that traditional builders in the West region were less likely than any other region to have never heard of SFI certified wood.

Building Product Environmental Attributes

![Importance of Building Material Attributes Graph](image-url)
Respondents were asked to rate the importance of building material attributes on a scale of 1 to 5 with 1 indicating not at all important, 3 indicating neutral, and 5 indicating extremely important. Based on the responses the attributes can be separated into two groups, “important” and “neutral/unimportant”. Attributes such as availability, long life, overall price, low maintenance, energy efficiency, ease of installation, and consumer demand were considered important attributes to both green and traditional builders. Neutral/unimportant attributes for both builder groups were, locally produced material, recyclability of the material, made with renewable raw materials, energy usage during the manufacture process, and CO₂ emissions during manufacturing.

The data suggests technical and economic attributes were considered more important for green and traditional builders. Green builders ranked significantly higher the importance of environmental attributes of building materials in material selection. The data suggests green builders have higher levels of awareness for the environmental impact of building materials.

Statistical analysis was conducted using independent samples t-test to test for statistically significant differences in the mean ranking of green builders and traditional builders. The results indicate green builders ranked statistically significantly higher the attributes; long life, low maintenance, energy efficiency, locally produced material, recyclability of the material, made with renewable raw materials, made with recycled materials, energy usage during the manufacture process, and CO₂ emissions during manufacturing (figure 8).
**Wood, Steel, Concrete Comparison**

Respondents were asked to rate the environmental performance of wood compared to steel and concrete on the basis of 6 environmental attributes. The environmental attributes considered in the survey were; 1) CO\textsubscript{2} emissions during the manufacturing process, 2) highly renewable material, 3) contributes to the high energy efficiency of the completed house, 4) uses low energy in the manufacturing process, 5) has a long life, and 6) recyclable. The ranking was based on a five point Likert scale with one indicating strongly disagree, three meaning neutral, and 5 indicating strongly agree. The data shows wood ranked higher than steel on 4 out of the 6 attributes and higher than concrete on 5 of the 6 attributes. Builders in general ranked steel and concrete higher than wood for the attribute, has long life, and builders ranked steel higher than wood for the attribute, recyclable. The data indicates wood had a positive ranking by green and traditional builders, above three, for all of the environmental attributes (figure 9).

Green and traditional builders reported their perceptions of environmental attributes for the materials wood, steel, and concrete. Green builders n = 227 and traditional builders n = 273. Statistical analysis using an independent samples t-test was conducted to compare differences in mean ranking between green and traditional builders in their perception of the environmental attributes for wood, steel, and
concrete. There were statistically significant differences between the builder groups in their perceptions of the environmental attributes for wood, steel, and concrete.

For the attribute, **has low CO₂ emissions during the manufacturing process**, a significant difference was reported for steel between green builders (M=2.29, SD=.837) and traditional builders (M=2.49, SD=.887), conditions; t(498)=2.585, p=.010. A significant difference was reported for concrete between green builders (M=2.60, SD=.983) and traditional builders (M=3.04, SD=.776), conditions; t(498)=5.506, p=.000.

Traditional builders more strongly agree that steel and concrete have low CO₂ emissions during the manufacturing process as compared to green builders.

For the attribute, **highly renewable material**, a significant difference was reported for wood between green builders (M=4.16, SD=.826) and traditional builders (M=4.00, SD=.905), conditions; t(498)=1.982, p=.048. A significant difference was reported for steel between green builders (M=3.05, SD=1.252) and traditional builders (M=3.29, SD=1.068.), conditions; t(498)=2.322, p=.021.

Green builders more strongly agree that wood is a highly renewable material than traditional builders. Traditional builders agree more strongly than green builders with the perception that steel and concrete are highly renewable materials, concrete is not a significant difference.

For the attribute, **contributes to high energy efficiency of the completed house**, a significant difference was reported for wood between green builders (M=3.01, SD=1.066) and traditional builders (M=3.29, SD=.845), conditions; t(498)=3.230, p=.001. A significant difference was reported for steel between green builders (M=2.50, SD=.933) and traditional builders (M=2.66, SD=.855.), conditions; t(498)=2.063, p=.040.

Traditional builders agreed more strongly than green builders with the perception that wood and steel contribute to the high energy efficiency of the completed house.

For the attribute, **uses low energy during the manufacturing process**, a significant difference was reported for steel between green builders (M=2.09, SD=.828) and traditional builders (M=2.36, SD=.824), conditions; t(498)=3.543, p=.000. A significant difference was reported for concrete between green builders (M=2.57, SD=.963) and traditional builders (M=2.91, SD=.813), conditions; t(498)=4.273, p=.000.

Traditional builders agree more strongly than green builders with the perception that steel and concrete to use low energy during the manufacturing process.

For the attribute, **has long life**, a significant difference was reported for steel between green builders (M=4.45, SD=.711) and traditional builders (M=4.29, SD=.660), conditions; t(498)=2.545, p=.011. A significant difference was reported for concrete between green builders (M=4.40, SD=.724) and traditional builders (M=4.22, SD=.709), conditions; t(498)=2.748, p=.006.

Green builders perceive steel and concrete to have a long life significantly more than traditional builders.

For the attribute, **recyclable**, a significant difference was reported for steel between green builders (M=4.45, SD=.679) and traditional builders (M=4.24, SD=.728), conditions; t(498)=3.273, p=.001.
Green builders more strongly agree that steel and concrete are recyclable than traditional builders, with steel being a significant difference. These results suggest both green and traditional builders view wood as an environmentally friendly building material as demonstrated by the positive ranking for all of the attributes. Both builder groups view wood as superior to steel in 4 of the 6 attributes and superior to concrete in 5 of the 6 attributes.

The data indicates green and traditional builders have similar views of the environmental performance of wood as a building material, they differed significantly on only one attribute. Green and traditional builders showed significant differences on their view of steel on all of the attributes and concrete on 3 of the 6 attributes. In general, traditional builders had a more favorable opinion of steel and concrete than green builders on the more environmental attributes and green builders tended to have a more favorable opinion of steel and concrete on the last two attributes, which are more based on knowledge of the material.

Conclusions

The analysis presented in this study demonstrates significant differences between green and traditional builders in their use of FSC and SFI environmentally certified wood. The significant association between census regions and green and traditional builders indicates that builders in the west region were significantly more likely to be green builders while builders in the Midwest are significantly more likely to be traditional builders. The data indicates green and traditional builders were not evenly distributed throughout the U.S. Green builders were significantly more likely to be frequent users of FSC certified wood and occasional users of SFI certified wood across all census regions. The data suggests a builders’ involvement in a green building program has a considerable influence on their use of environmentally certified wood. Therefore, manufacturers seeking to supply certified wood to green builders may benefit from concentrating on regions with a larger population of green builders, in particular, urban / suburban areas where green builders construct about 60% of their homes.

The study found significant differences in the use and awareness levels of FSC and SFI certified wood between green and traditional builders when grouped into small, medium, and large firms based on revenue. Green builders were significantly more likely to be frequent users of both FSC and SFI certified wood in all revenue groups. The data shows small and medium size green builders were more than two times as likely to be frequent users of certified wood as large green builders. Specifically marketing certified wood to small and medium size green homebuilders may be a productive strategy given that they are the most frequent users. The data indicates roughly 40% of traditional builders of all sizes had not heard of FSC or SFI certified wood, therefore given the projected increase of green building in the U.S. this group presents a large market for environmentally certified wood products.

The results of this study indicate builders view the cost of certification and the complicated documentation process as main reasons for not using LEED for Homes. Reducing the certification costs and complexity of the documentation process would address the main reasons builders chose not to use LEED for Homes. Green and traditional builders use LEED and NGBS mainly because it helps differentiate their homes in the market. Highlighting the benefits and factors that differentiate a green home from a conventional home would ensure continued support for RGBPs among green and traditional builders. Increasing consumer education about the benefits of green homes from an environmental and economic perspective would help to increase homebuilders use of RGBPs given that a lack of consumer
demand and consumers not willing to pay a premium for green homes were reported as main reasons for not using these programs.

Green and traditional builders differed only slightly in their main reason for not using FSC and SFI certified wood with their top reason being, no customer demand. Educating consumers on the benefits of forest certification and environmentally certified wood would address the main reason both builder groups chose not to use certified wood. Green builders indicated their top reason for using FSC and SFI wood was it contributes significantly to green building points, which demonstrates the importance of RGBPs in the demand for certified wood among homebuilders. Expanding the role of certified wood in RGBPs, either by increasing points for certified wood use or possibly subtracting points for not using certified wood, would have an impact on FSC and SFI use by homebuilders. Furthermore, green builders ranked promoting a green image of their company as a main reason for using certified wood. Increasing public awareness of the environmental benefits of certified wood as well as expanding a homebuilders ability to publicly display their use of certified wood would serve to support one of their main reasons for choosing certified wood.

Environmental attributes of building materials were statistically significantly rated as more important by green builders indicating a higher awareness of the environmental impact of building materials. In general, green builders and traditional builders both ranked the economic / technical attributes of building materials more positively than the environmental attributes. Manufacturers supplying builders with green products may benefit from understanding the importance green builders place on environmental attributes of building materials.

Comparing the environmental performance of wood relative to steel and concrete, green and traditional builders ranked wood more positively than steel on 4 of the 6 attributes and rated wood more positively than concrete on 5 of the 6 attributes. Green and traditional builders tend to have similar positive views of the environmental performance of wood relative to steel and concrete. Both builder groups gave wood a positive rating, above 3.0, on all of the 6 environmental attributes. Highlighting the environmental benefits of using wood as a building material relative to steel and concrete should result in increased use of certified wood in building projects considering both builder groups reported the environmental benefits of certified wood was one of the most important reasons in their choice to use FSC and SFI wood.

The continued growth of residential green building programs and the residential green building market suggests the importance of environmentally certified wood products will increase. Both builder groups appear to be waiting for consumer demand for certified wood to increase before incorporating more FSC and SFI wood in their home construction and remodeling projects. Educating consumers on the environmental benefits of certified wood should have a positive impact on the use of FSC and SFI wood by green and traditional builders going forward. Furthermore, traditional builders who were more likely to be remodelers and therefore have more interaction with a homeowner as compared to a homebuilder would be more likely to incorporate more ECWPs in their remodeling projects as consumers request certified products. This would also allow green builders to more effectively promote a green image of their company as home buyers become more aware of the importance of certified wood on improving forest governance globally. At the same time, traditional builders, not motivated by green building points, could take advantage of consumer awareness to increase their use of certified
wood given they already hold the opinion that certified wood provides a substantial environmental benefit.
References


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