Comparing Wood versus Concrete: An Explorative Study of Municipal Civil Servants' Beliefs About Multistory Building Materials in Finland

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Abstract

The rising interest in wooden multistory buildings (WMSB) has led to multiple studies investigating how construction professionals perceive different structural frame materials. These investigations, however, exclude viewpoints from public employees (i.e., civil servants), who are central to driving the implementation of WMSB. This study is part of a broader inquiry to examine perceptions from Finnish civil servants who are responsible for municipal land-use planning and development. To this end, a questionnaire applying the theory of planned behavior was designed. Civil servants were asked to evaluate how strongly they believe WMSB possess 16 attributes in comparison to concrete multistory buildings (CMSB). The attributes constitute statements concerning various economic, social, and environmental impacts of multistory buildings, as well as technical properties. Responses ($N = 273$) indicate that WMSB are believed to possess positive environmental attributes and to support economic development. In contrast, CMSB are regarded to have lower construction and maintenance cost and to be less susceptible to fire. Furthermore, exogenous factors, like demographics, previous experience, and social environments, were significantly correlated to respondents' beliefs. Especially prominent was the relationship between profession and beliefs about technical and environmental attributes. Future research should focus on determining whether the set of attributes assessed in this study are relevant to the implementation of multistory building projects within Finnish municipalities.

In many countries, public and private interest in the construction of wooden multistory buildings (WMSB)[1] is increasing. The emergence of WMSB stem from the adoption of science and technology policies alongside industry entrepreneurship (Lazarvic et al. 2020). Public support is evident in North America (e.g., H.R. 1380 2017; United States' Timber Innovation Act 2017, S. 538) and in the European Union (e.g., European Commission's Bioeconomy Strategy; European Commission 2018). Concurrently, entrepreneurial interest and industry support is reflected in the International Code Council's 2018 decision to include mass timber construction (e.g., WMSB) into their 2021 edition of *International Building Code* (American Wood Council 2018). These model codes provide performance standards for the health and safety of buildings constructed throughout the United States, both in the regulatory and nonregulatory settings (ICC 2018, p. iii).

[1] Wooden multistory building refers to a multistory building whose structural frame material is primarily wooden, usually an engineered wood product like cross-laminated timber (CLT). For more information see Ramage et al. (2017).

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Interest in WMSB is spurred by multiple drivers, including political motivation rooted in climate change agenda objectives to reduce greenhouse gas emissions (Hurmekoski et al. 2015, Toppinen et al. 2018) and to enable broader sustainable development goals. For example, Rajagopalan and Kelley (2017) implemented a multi-attribute decision tool to evaluate the sustainability of three alternative material frame buildings: CLT, steel, and concrete. According to ratings provided by an expert panel of building industry professional and academics, the CLT building was found to have the most social and environmental sustainability advantages due to possibilities for improving material waste management, material renewability, environmental stewardship, and local citizenship and equity.

In addition to the public interests, there exist industry drivers promoting the construction of WMSB. Several professionals (e.g., engineers, architects, and builders) have positive attitudes towards using wood as a construction material, given wood's environmentally friendly qualities, lightness, adaptability to industrial applications, and quick construction speed (Roos et al. 2010, Hemström et al. 2011, Conroy et al. 2018).

Nevertheless, alongside these approbations are a long list of criticisms and uncertainties. For example, professionals hold technological concerns about the fire resistance, humidity, and acoustic performance of WMSB (Hemstörm et al. 2011, Gosselin et al. 2017). Perceptions of high cost also limit motivation for project acceptance (Jones et al. 2016, Gosselin et al. 2017). Ultimately, such negative industry perceptions about WMSB culminate in favoritism for the traditional solution to multistory construction: using concrete as the primary frame material (Mahapatra and Gustavsson 2008, Hemström et al. 2017). For overcoming this path-dependency, the literature prescribes public sector intervention, such as policy instruments (Hildebrandt et al. 2017, Hurmekoski et al. 2018). Ultimately, the role of government is acknowledged as central to the innovation diffusion of WMSB (Weiss et al. 2020).

In some counties, local government actors (i.e., civil servants) are granted vast authority in the oversight of national building codes and regulations. One such example is in Finland, where municipal civil servants hold legally legitimate authority over local land-use development and decision-making (132/1999 2003). Finnish municipalities employ civil servants to implement land-use planning through various functions, such as zoning, environmental inspection, building inspection and certification, and development planning. Some municipalities also employ development divisions to manage the construction of publicly procured projects (e.g., Helsingin Asuntotuotantotoimistos). Such responsibilities provide Finnish civil servants with significant opportunities to advance sustainable development goals (Säynäjoki et al. 2014), for instance, via key roles in building material decision-making (Lähtinen et al. 2019).

Meanwhile, for the last 25 years, Finland's central government has supported the entry of WMSB into the residential housing market (Lazarvic et al. 2020) through various national development programs (e.g., The Wood Building Program 2016-2021; YM 2020a) and government strategic programs (e.g., Prime Minister's Office 2016, p. 67). In a more recent example, the Ministry of Environment set targets to increase the number of wooden buildings constructed by 2025 (YM 2020b). One of the targets is that at least 45% of residential multistory buildings publicly procured by municipalities should be WMSB. These targets are justified through a statement declaring that wood construction helps achieve sustainable development goals by reducing carbon dioxide emissions while supporting the domestic economy (YM 2020b, p. 2). Thusly, the statement both acknowledges the role of municipalities in public procurement and suggests that public procurement serves as a driver of sustainable solutions.

On the ground at the local level, however, a total of only 90 WMSB projects have been finalized since the introduction of WMSB into the Finnish housing market in 1995 (PuuInfo 2020). These buildings represent a mix of privately and publicly procured projects. Little can be said about how Finnish civil servants perceive this contradiction between central government directives and local-level implementation. At this time, few studies provide perspectives about WMSB exclusively from the view of Finnish municipal civil servants (Franzini et al. 2018, Lähtinen et al. 2019), therefore whether WMSB are perceived to be viable sustainable alternatives remains to be seen.

This paper aims to benchmark the perceptions Finnish municipal civil servants have towards WMSB by comparing beliefs about WMSB relative to the business-as-usual solution (i.e., concrete multistory buildings [CMSB]). An empirical survey of Finnish municipal civil servants was conducted to address the following questions:

1. How do municipal civil servants involved in the decision-making of municipal land-use planning and development compare attributes of wooden multistory buildings relative to concrete multistory buildings?
2. Do different backgrounds or experiences correlate to how these attributes are perceived by municipal civil servants?

Methodology

The theory of planned behavior as a theoretical framework

We applied the theory of planned behavior (TPB) as the framework for a survey study investigating the perceptions of municipal civil servants. Previous research has successfully applied TPB to investigate perceptions that professional hold towards using wood as a frame material for multistory construction (Bysheim and Nyrud 2009, Roos et al. 2010, Hemström et al. 2011); however, these studies omit focusing on public sector stakeholders.

TPB postulates that an individual's intention to perform a behavior can be predicted according to three constructs: attitudes towards the behavior, subjective norm, and perceived behavioral control (Ajzen 1991). Simply put, if an individual has a positive attitude towards a behavior, perceives others to approve of the behavior, and believes they have control over carrying out the behavior, then they likely intend to carry out the behavior.

The formation of these three constructs is predicated by beliefs. Beliefs are not innate, instead, they result from direct observation, outside information, or inference; beliefs are the acquisition of various learned experiences tied to

multiple background factors (Fishbein and Ajzen 2010, p. 224). Therefore, beliefs are at the core of exploring—and explaining—why individuals hold attitudes, subjective norms, and perceptions of control over behaviors (Ajzen, 2005, p. 123).

Each construct of TPB has its own underlying determinant beliefs (Ajzen 1991, 2005). Attitudes towards a behavior stem from *behavioral beliefs* about the consequences of the behavior and an assessment of the outcome of that consequence. These consequences are sometimes referred to as ''attributes'' (Fishbein and Ajzen 2010, pp. 96–97). Subjective norms stem from *normative beliefs* about whether social referents approve or disapprove of the behavior and the motivation to comply with the said referent. Perceived behavioral control stems from *control beliefs* about the availability of resources that facilitate or impede performing the behavior. Importantly, TPB operationalizes these antecedent beliefs through a set of evaluative items on a survey, thus facilitating a statistical analysis of how the respondents perceive the behavior in question.

In this paper, we focus exclusively on behavioral beliefs. In TPB, behavioral beliefs are operationalized through an expectancy-value model. Mathematically, the model is represented as Equation 1, where attitudes towards a behavior (A_B) are proportional to the strength of a belief that a behavior will have a certain attribute (b_i), and a subjective evaluation about that attribute (e_i; Ajzen 1991). Note that the scope of this paper is only to report how strongly civil servants believe WMSB hold certain attributes (b_i), rather than how the civil servants evaluate the outcome of the attributes (e_i).

$$A_B \propto \sum b_i e_i \tag{1}$$

Survey development based on TPB

The dataset was collected through a comprehensive electronic survey which included 111 questions. These questions constitute the standard elements of a TPB questionnaire (Ajzen 2019). This includes direct measures for attitude, subjective norm, perceived behavioral control, and intention, as well as measurements of behavioral, normative, and control beliefs. In addition, personal background information was collected. The survey was drafted into English and then translated into Finnish with assistance from a bilingual expert in the field of architecture. Translations were checked by coauthors and colleagues. The final survey was evaluated by seven civil servants.

The belief items were formulated according to the standard method for constructing a TPB questionnaire (Fishbein and Ajzen 2010, Ajzen 2019). First, modal beliefs were elicited from representatives of the target population via 11 exploratory interviews (Franzini 2018). The interviews yielded a content analysis list of frequently discussed ''benefits,'' ''actors,'' and ''barriers.'' From this list, the behavioral, normative, and control belief items were drafted and then validated by three civil servants employed by small-sized municipalities.

Background questions were formulated based on the acknowledged associations that demographics, knowledge, and the social environment have on belief formation (Fishbein and Ajzen 2010). Each of these background factors was operationalized through various questions. Demographic questions included gender, age, education, and profession. Knowledge questions included asking if the respondent had previous experience working with WMSB, and what type of residential building they currently occupied. Social environment questions included asking in which municipality the respondent was employed, and the length of tenure employed in the municipality.

Data collection

The survey was distributed electronically via e-mail to targeted civil servants employed in municipalities across mainland Finland (296 municipalities in 2019). The target group included civil servants with duties that directly or indirectly impact land-use planning and development in their municipality. E-mail addresses were manually collected from the publicly listed webpage of each municipality because no publicly available e-mail database of civil servants was available.

Since municipal organizational structures vary in terms of workforce size and workplace functions, e-mail addresses were collected at the discretion of the principal researcher. The e-mail addresses were chosen based on the employee's job title, and whether the job title could fulfill one of the following workplace functions: strategic land-use decision-making, land-use planning or design, property management, building and construction supervision, or environmental planning or inspection.

This manual collection of e-mails introduces a source of bias if targeted civil servants were unintentionally excluded due to human error or because municipal webpages lacked up-to-date employee contact information. Similarly, it is possible that irrelevant employees were e-mailed; however, this limitation is lessened by the survey statement page which outlined to respondents the purpose of the study and the intended target group. Ultimately, a total of 3,537 e-mails addresses were collected into a mailing list; however, 442 of these emails failed to deliver to their respective email addresses. Only 3,095 e-mail addresses were usable.

Respondent demographics

We collected 289 surveys, of which 273 were usable after removing corrupt or duplicate surveys, and surveys missing more than 15% of multiple-choice responses. Because the mailing list intended to comprise the total population of the target group, the 8% response rate reflects responses from 8% of the total target population.

Table 1 depicts the respondent demographics. The mean age of respondents was 49, with less than 22% of respondents being younger than 40. Most respondents identified as being responsible for land-use planning tasks (38.3%). A large portion of respondents listed the ''other'' job function (16.4%), and further expanded about their duties through a written response. Inspection of written responses showed 13 individuals accredited themselves with performing tasks related to environmental inspection, which was unavailable as a response option in the questionnaire. The remaining open-ended responses discussed multifaceted responsibilities like construction, real estate development, spatial engineering, and policymaking.

Table 1.—Respondents' demographics.

Background factors	No. (%)
Gender	
Male	165 (62.5)
Female	98 (37.1)
Age (yr)	
18–29	11 (4.5)
30–39	45 (18.2)
40–49	53 (21.5)
50–59	88 (35.6)
60–69	50 (20.2)
Job function	
Land-use planning	98 (38.3)
Real estate management	28 (10.9)
Building inspection	48 (18.8)
Strategic senior management	41 (16)
Other	42 (16.4)
Environmental inspection	13 (5.1)

Table 2.—List of the attributes of multistory buildings, attributes statements evaluated by respondents, and the background factors tested against responses.

Parameter
Attributes of multistory buildings
Fire susceptibility
Mold susceptibility
Indoor air quality
Building's service life
Carbon dioxide impacts
Recyclability
Ease of implementing construction project
Environmentally friendly
Aesthetic
Cost to build
Cost to maintain
Economic contribution to value of an area
Value-added product for domestic industries
Investment safety (financial)
Impact on municipal economy
Impact on municipal brand
Attribute statements (b_i)
Less susceptible to fire
Less susceptible to mold
Less susceptible to poor indoor air
Longer life cycle
Lower carbon dioxide emissions
Easier to recycle
Easier to implement within reasonable schedule
More environmentally friendly
More beautiful
More expensive to build
More expensive to maintain
Contribute more to the economic value of the area
A greater value-added product for domestic industries
A financially safer investment
Better for my municipality's economy
Better for my municipality's brand
Background factors
Previous experience working with wooden multistory buildings
Previous residential occupancy
Length of tenure in employed municipality
Municipal population
Municipal population density
Profession
Educational degree
Gender
Age

Data analysis

Table 2 depicts the full set of variables analyzed in this study. Recall that this study analyses behavioral belief strengths (b_i), specifically, how strongly civil servants believe that WMSB possess certain attributes. This was assessed by asking the question: ''Compared to concrete multistory buildings, wooden multistory buildings are/have....'' Following the question, respondents were asked to evaluate 16 different attribute statements using a 5-point Likert scale (strongly disagree to strongly agree). The scale was scored in a bipolar fashion (from –2 to +2). The middle category (0) delineated a neutral evaluation of the statement (no difference). A 5-point Likert scale was chosen to encourage responses given the length of the survey.

Of the 16 attribute statements, 2 attribute statements posited that WMSB were in possession of a negative attribute (i.e., ''more expensive to build'' and ''more expensive to maintain''), while the remaining 14 attribute statements posited that WMSB were in possession of a positive attribute (Table 2). For the positive attribute statements (e.g., WMSB are ''more fire safe'' than CMSB), agreement with the statement indicates a preference for the attribute in WMSB. This is measured with a positive value (strongly agree: +2, agree: +1). For the statements constituting negative attributes (e.g., WMSB are ''more expensive to build'' than CMSB), agreement with the statement indicates a preference for the attribute in CMSB. Therefore, the evaluation scales for the two negative attribute statements were reverse coded (strongly agree: –2, agree: –1).

The responses to the attribute statements were analyzed by calculating mean values for each statement. A negative mean value is interpreted as preference for the attribute in CMSB, while a positive mean value is interpreted as preference for the attribute in WMSB. In addition, *t* tests were used to ascertain if the calculated mean values for each attribute statement was statistically different from a neutral value of 0.

One-way analysis of variance (ANOVA) was used to test whether background factors had an effect on how respondents evaluated the 16 attribute statements. The background factors were treated as the independent variables. This required that ordinal background factor variables be created from the survey background questions captured on a scale (i.e., year of birth, length of tenure, municipal population, municipal population density). These ordinal groups were created by splitting the scaled responses into equal quintile groups. Note that geographic background factors (i.e., municipal population and population density) information was compiled from online data (Statistics Finland 2019) according to the respondent's respective municipality.

Prior to the 1-way ANOVA testing, Levene's test was used to test homogeneity of variance. Items without

homogeneity were excluded from 1-way ANOVA analysis. Statistically significant ANOVA results were subject to post-hoc analysis using Tukey's test to determine between which groups the statistically significant differences in means occur.

Results

Attribute comparison: Wooden multistory building versus concrete multistory buildings

Table 3 presents the mean values and *t* test results for the 16 attribute statements that civil servants evaluated. There were three attributes statements with negative mean values: ''more expensive to maintain,'' ''more expensive to build,'' and ''less susceptible to fire.'' These attributes are interpreted as being preferable in CMSB.

Two attribute statements held insignificant *t* tests, indicating that the mean value of these statements is not statistically different from a neutral value of 0. This included the statements ''less susceptible to mold'' and ''longer life cycle.'' Therefore, respondents perceive these attributes to be the same between WMSB and CMSB.

The remaining 11 attribute statements held positive mean values, thereby suggesting that, on average, these attributes are preferred in WMSB. The largest positive mean values were accorded to statements regarding environmental dimensions (i.e., ''more environmentally friendly,'' ''lower carbon dioxide emissions,'' ''easier to recycle''), and economic development (i.e., ''a greater value-added product for domestic industries,'' ''better for my municipality's brand'').

Table 3.—Attribute statements evaluated by respondents. Preceding the statement was the primer, "What views do you have on the following statements? Compared to concrete multistory buildings, wooden multistory buildings are/have…." Response scale was from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

Attribute statement	Mean (SD)	*t*
More expensive to build	−0.47 (0.85)[b]	8.83
Less susceptible to fire	−0.40 (0.78)	−8.38
More expensive to maintain	−0.22 (0.79)[b]	4.42
Less susceptible to mold	−0.10 (0.91)[a]	1.69[a]
Longer life cycle	0.01 (0.81)[a]	0.23[a]
A financially safer investment	0.09 (0.69)	2.17
Easier to implement within reasonable schedule	0.29 (0.90)	5.20
Better for my municipality's economy	0.36 (0.68)	8.34
Less susceptible to poor indoor air	0.60 (0.90)	10.98
Contribute more to the economic value of the area	0.81 (0.72)	18.19
More beautiful	0.91 (0.87)	17.2
A greater value-added product for domestic industries	1.17 (0.70)	27.46
Easier to recycle	1.20 (0.81)	24.51
Better for my municipality's brand	1.26 (0.66)	31.39
Lower carbon dioxide emissions	1.28 (0.72)	29.03
More environmentally friendly	1.34 (0.64)	34.47

[a] The item's mean value does not show a large enough difference from a neutral value of 0.

[b] Measurement scales for these statements were reverse-coded to facilitate ranking.

Background factors shaping beliefs: Experiences, the social environment, and demographics

Table 4 presents the *P* value results from the 1-way ANOVA tests between attribute statements and background factors. The table shows that all the background factors were statistically associated with at least one attribute statement. Note there were six attribute statements that did not have a significant relationship to any background factor. This included the statements, ''less susceptible to mold,'' ''more expensive to build,'' ''a financially safer investment,'' ''better for my municipality's economy,'' ''easier to implement within reasonable schedule,'' and ''a greater value-added product for domestic industries.''

Figures 1 through 9 depict the between-group comparisons of the statistically significant 1-way ANOVA tests by providing the means of attribute statements according to the independent variable groupings (i.e., background factor groups). Following are results elaborating significant findings from the figures and their respective post-hoc Tukey tests.

The role of previous experiences

Figure 1 depicts the three attribute statements significantly associated with the background factor previous experience working with WMSB. The figure shows respondents from the group who did possess previous experience working with WMSB held lower mean values for the attribute statement ''more beautiful'' and ''contribute more to the economic value the area.'' On the other hand, they held a higher mean value for the attribute statement ''easier to recycle.''

Figure 2 depicts the two attribute statements significantly associated with the background factor previous residential occupancy. Respondents from the single-family house group held a higher mean value for the attribute ''more beautiful'' compared to the multistory apartment group. The post-hoc Tukey's test revealed significant differences between these two groups ($P = 0.025$).

The role of the social environment

Figure 3 depicts the two attribute statements significantly associated with the background factor length of tenure in employed municipality. The group with 1 to 2 years of tenure held the lowest mean value for the attribute statement ''less susceptible to fire'', while the group with 8 to 14 years of tenure held a mean value close to zero. The post-hoc Tukey's test revealed significant differences between these two groups ($P = 0.003$).

Figure 3 also shows that the group with 1 to 2 years of tenure and the group with 15+ years of tenure hold a mean value close to zero for the attribute statement ''more expensive to maintain,'' while the intermediate groups hold negative mean values. Note these ANOVA findings may be inconclusive, as the post-hoc Tukey's test revealed no significant differences between any tenure groups.

Figure 4 depicts the two attribute statements significantly associated with the background factor municipal population. For both the attributes statements ''more beautiful'' and ''contribute more to the economic value of the area,'' the group of respondents employed by the least populated

Table 4.—One-way analysis of variance outputs between attribute beliefs statements and background factors. Bold text indicates significance.

Attribute statement	Previous work with WMSB	Residential occupancy	Age	Current tenure length	Municipal profession	Gender	Educational degree	Municipal density	Municipal population
Less susceptible to fire	0.147	0.161	**0.042***	**0.008****	0.505[a]	0.674	**0.010****	0.154	0.083
Less susceptible to mold[b]	0.743[a]	0.227	0.888	0.274	0.004[a]**	0.140	0.057	0.062	0.447
Less susceptible to poor indoor air	0.954	0.024[a]*	0.458[a]	0.676	**0.014***	0.141	**0.039***	0.246	0.662
Longer life cycle	0.865	0.549	0.595	0.095	**0.007****	**0.004****	**0.005****	0.482	0.547
Lower carbon dioxide emissions	0.413	0.149	0.584	0.925	**0.00****	0.116	0.00[a]**	0.054	0.496
Easier to recycle	**0.048***	0.480	0.173	0.430[a]	**0.029***	0.549	0.525[a]	**0.016***	0.454
Easier to implement within reasonable schedule[b]	0.944	0.826	0.240	0.084	0.244	0.406	0.500	0.336	0.809
More environmentally friendly	0.351	0.400	0.531	0.948	**0.003****	0.239	0.107	0.043[a]*	0.564
More beautiful	**0.001****	**0.009****	0.587	0.140	0.282	0.147	0.389	**0.012***	**0.019***
More expensive to build[b]	0.815	0.652	0.516	0.085	0.576	0.968	0.699	0.481	0.196
More expensive to maintain	0.225	0.424	0.603	**0.028***	0.430	0.440	0.801	0.120	0.305
Contribute more to the economic value of the area	**0.002****	0.284	0.378	0.015[a]*	0.983	0.066	0.733	**0.004****	**0.009****
A greater value-added product for domestic industries[b]	0.989	0.895	0.244	0.741	0.858[a]	0.440	0.882[a]	0.104	0.832
A financially safer investment[b]	0.980	0.506	0.939[a]	0.869	0.224	0.190	0.362[a]	0.011[a]*	0.155
Better for my municipality's economy[b]	0.552[a]	0.754	0.529	0.314[a]	0.088[a]	0.495	0.242[a]	0.052[a]	0.282[a]
Better for my municipality's brand	0.157	**0.034***	0.475	0.735	0.053	**0.001****	0.004[a]**	0.355	0.111

* Indicates a significant figure below $P = 0.05$.

** Indicates a significant figure below $P = 0.01$.

[a] Indicates the Levene's test for homogeneity failed; ANOVA result is inconclusive (P value results from Levene's test are available from the primary author upon request).

[b] Indicates the attribute statement has no significantly associated background factor.

Figure 1.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "previous experience working with WMSB." Response scale from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

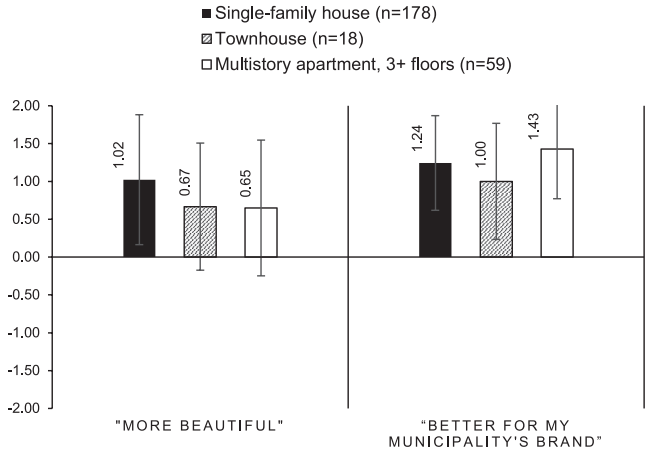

Figure 2.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "previous residential occupancy." Response scale from –2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

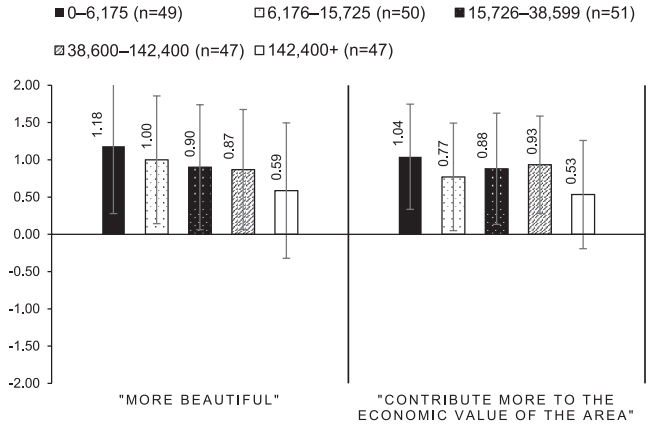

Figure 4.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "municipal population." Response scale was from –2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

municipalities held the highest mean values, while the group of respondents employed by the most populated municipalities held the lowest mean values. For both attributes, the post-hoc Tukey's test revealed significant differences between these two groups ($P = 0.008$ and $P = 0.006$, respectively).

Figure 5 depicts the three attribute statements significantly associated with the background factor of municipal population density. Respondents from the smallest population-density group held the largest mean values for the attributes ''more beautiful'' and ''contribute more to the economic value the area.'' Conversely, respondents from the largest population-density group held the smallest mean values for these attributes. For both attributes, the post-hoc Tukey's test revealed significant differences between these two groups ($P = 0.004$ and $P = 0.001$ respectively).

Figure 5 also depicts that employees from the second smallest group (population 8.1 to 23.7 people/km^2) held the lowest mean value for the attribute statement ''easier to recycle.'' The post-hoc Tukey's test revealed that this group was significantly different from the smallest group ($P = 0.048$) and the second largest group ($P = 0.021$).

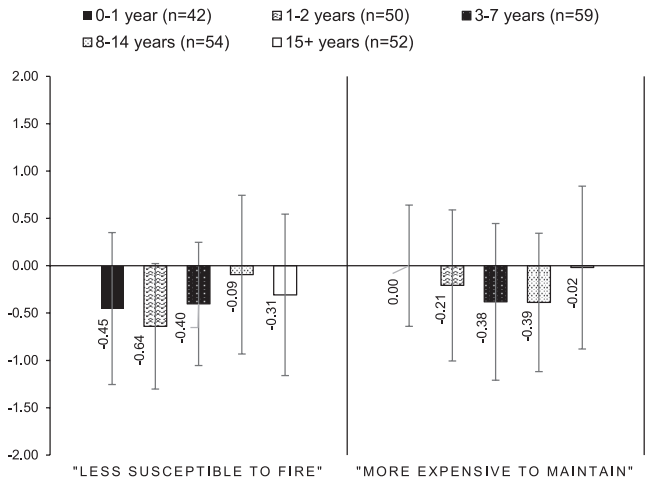

Figure 3.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "length of tenure in employed municipality." Response scale from –2 to 2 (strongly disagree/disagree/the same/agree/strongly agree), however, scales are reversed for the attribute statement "More expensive to maintain."

The role of demographics

Figure 6 depicts the five attribute statements significantly associated with the background factor profession. An overall scan of the figure shows that the planner group held the highest mean values for all five attributes. Meanwhile, the real estate managers group and the building inspectors group held the lowest mean values for all five attributes. Furthermore, they were the only groups to hold negative mean value for the attribute statement ''longer life cycle.'' Overall, the Tukey's test revealed that real estate managers and building inspectors tended to have significantly different beliefs than their peers.

Specifically, the Tukey's test revealed that environmental inspectors were significantly different from both real estate managers ($P = 0.047$) and building inspectors ($P = 0.027$) when regarding the attribute statement ''longer life cycle.'' In addition, planners were significantly different from real estate managers and building inspectors when regarding the attribute statement ''lower carbon dioxide emissions'' ($P = 0.002$ and $P = 0.000$, respectively) and ''more environmentally friendly'' ($P = 0.039$ and $P = 0.010$, respectively).

Figure 7 depicts the three attributes statements significantly associated with the background factor educational degree. Observe that these three attributes concern technical properties of buildings, and two of these attributes, ''less susceptible to poor indoor air'' and ''longer life cycle,'' were also associated with the respondent's profession (Fig. 6).

A scan of Figure 7 shows that for the attribute statements ''less susceptible to fire'' and ''less susceptible to poor indoor air'' respondents from the vocational degree group

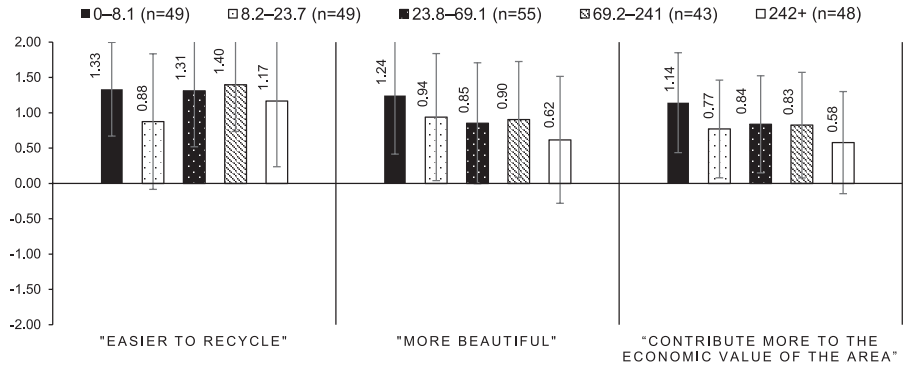

Figure 5.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "municipal population density." Response scale was from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

held the lowest mean values, while respondents from the master's degree group held the highest mean values. For both these attribute statements, the post-hoc Tukey's test was significant between these two groups ($P = 0.023$ and $P = 0.041$, respectively).

On the other hand, for the attribute statement ''longer life cycle,'' respondents from the bachelor's degree group held the lowest mean values, while respondents from the master's degree group held the highest mean values. The vocational degree group held a neutral mean value. For this attribute, the post-hoc Tukey's test revealed that only the college bachelor's degree group and the university master's degree group were significantly different ($P = 0.004$).

Figure 8 depicts the two attribute statements associated with the background factor of gender. The figure shows that women held higher mean values for both statements. Men held a negative mean value for the ''longer life cycle,'' whereas women held a positive mean value. The same trend, where one group held a negative mean value while another held a positive mean value, was also observed in Figure 6 (profession) and Figure 7 (education).

Figure 9 depicts the one attribute statement associated with the background factor of age: ''less susceptible to fire.'' While all groups held negative mean values, the youngest group (ages 30 to 38 years) held the lowest mean value, while the oldest group (ages 60 to 68 years) held the highest mean value. This trend corresponds with that depicted in Figure 3 (i.e., length of tenure). The post-hoc Tukey's test comparing the youngest group and the oldest group was borderline significant ($P = 0.051$).

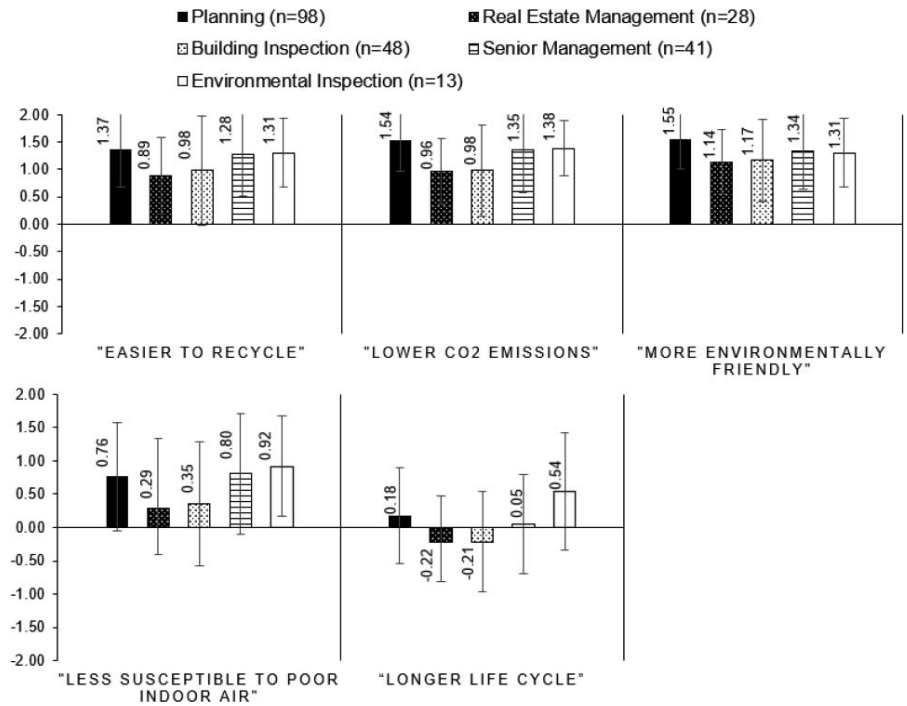

Figure 6.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "profession." Note that while the "other" professional cohort is omitted from the figure, it was included in the analysis of variance. Response scale was from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

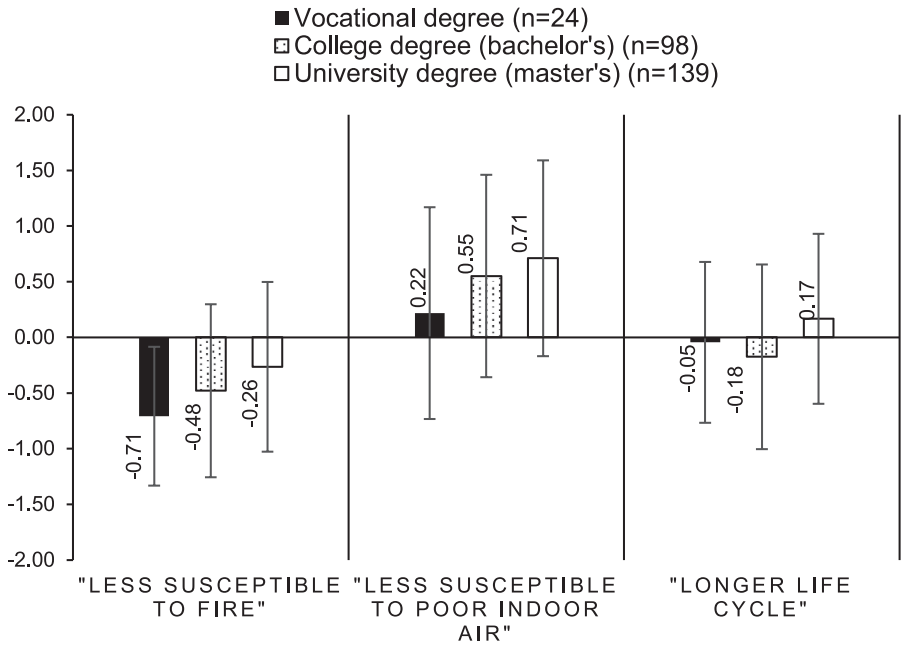

Figure 7.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "educational degree." Response scale was from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

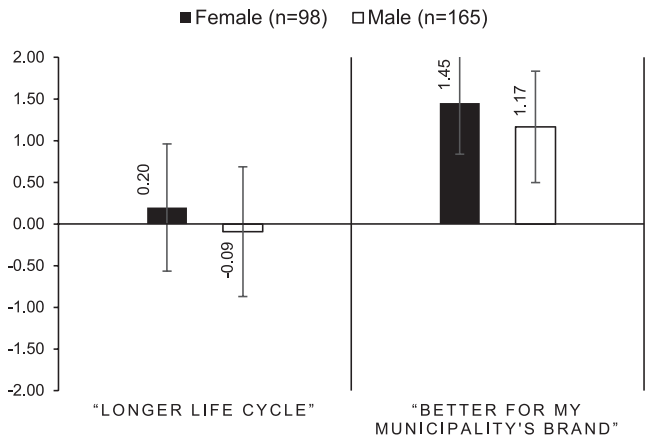

Figure 8.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "gender." Response scale was from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

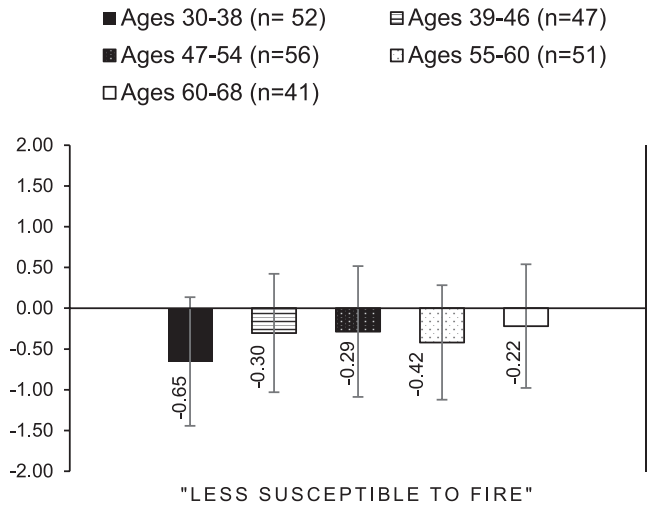

Figure 9.—Between-group comparison of mean values for attribute statements significantly associated with the background factor "age." Response scale was from −2 to 2 (strongly disagree/disagree/the same/agree/strongly agree).

Discussion and Conclusions

This research aimed to benchmark how municipal civil servants responsible for land-use planning compare various attributes of WMSB versus CMSB. These perceptions were collected through a survey that implemented TPB to gather behavioral beliefs about WMSB. Specifically, civil servants evaluated how strongly they believe WMSB to hold certain attributes. The evaluated attributes constituted statements about the technical performance, environmental impacts, economic impacts, and social impacts of multistory buildings. In addition, these beliefs were analyzed against previous experiences, social environment, and demographic background questions.

According to the responses collected from 273 respondents, WMSB possess several advantageous attributes compared to CMSB. Civil servants strongly believed that WMSB possess positive environmental qualities (i.e., ''more environmentally friendly,'' ''easier to recycle,'' and ''lower carbon dioxide emissions''). These environmental beliefs are consistent with previous research citing professionals as having positive attitudes towards the environmentally friendly aspects of wood (Gosselin et al. 2017, Markström et al. 2018). All three environmental beliefs linked to the respondent's profession within the municipality, hence it is apparent that professional experience plays a key role in the formation of environmental beliefs about wooden material. Ultimately, planners held the strongest beliefs about the positive environmental qualities

of WMSB, while building inspectors and real estate managers held the weakest beliefs.

Attribute statements about technical properties of WMSB received mixed evaluations. Firstly, respondents regarded WMSB as being less susceptible to poor indoor air. This is in line with results reported in previous research (Gosselin et al. 2017, Markström et al. 2018). This belief was linked to the profession and education of the respondent. Respondents with higher-level education more strongly believe that WMSB are less susceptible to poor indoor air. Meanwhile, building inspectors and real estate managers held weak beliefs about WMSB being less susceptible to poor indoor air.

Secondly, respondents regarded WMSB and CMSB to be equally susceptible to mold. Previous research suggests otherwise, as professionals are typically concerned with wood having poor humidity and moisture resistance, and by extension susceptibility to mold (Gosselin et al. 2017). These beliefs were not significantly linked to any background factors tested in this study.

Thirdly, respondents evaluated WMSB as being more susceptible to fire than CMSB. In the literature, professionals typically cite fire as a concern with WMSB (Gosselin et al. 2017). Nevertheless, the finding was surprising, because previous research also indicates some Finnish civil servants identify WMSB as being more fire-safe than CMSB (Franzini et al. 2018). In addition, building fire codes in Finland were revised in 2017 to permit the construction of WMSB up to 16 floors (YM 2017), so a greater acceptance about the technical fire properties of WMSB would be feasible. Therefore, it is possible that in the face of a long history of fire and building codes regulating against WMSB, respondents receiving new evidence about the fire safety of WMSB may have trouble acknowledging or accepting the information. Such a reaction is not atypical, as research proposes that individuals tend to be conservative in the revision of their beliefs (Edwards 1982). Be that as it may, the attribute statement on fire susceptibility was linked to several background factors, including the respondent's age, length of tenure, and education. Notably, it is the youngest respondents (i.e., ages 30 to 38 years) who most strongly believed that WMSB are more susceptible to fire. Conversely the oldest respondents (ages 60 to 68 years) held weaker beliefs about susceptibility to fire. One possible explanation is that the Ministry of Environment's advocacy of wood construction (Lazarevic et al. 2020) successfully targeted more experienced urban planners. This would be in line with the suggestion by Lähtinen et al. (2019) that lobbying of urban planners in Finland typically targets experienced individuals.

Fourthly, the respondents, on average, evaluated the life cycles of WMSB and CMSB to be the same. This belief was associated with the respondent's profession, educational degree, and gender. It was observed that real estate managers and building inspectors, on average, believe that CMSB have longer life cycles than WMSB. This was notable because previous research indicates that Finnish developers and real estate managers are skeptical about WMSB development, but typically due to economic reasons (Riala and Illola 2014, Franzini 2018).

Lastly, on average the respondents believe that WMSB are easier to implement within reasonable schedule than CMSB. This is in line with previous literature citing the quick speed of wood construction as an advantage (Gosselin et al. 2017). This belief was not linked to any background factors measured in the study.

The attribute statements regarding economic impacts also received mixed evaluations. As in previous research (Gosselin et al. 2017), the respondents in this study believe WMSB to be more expensive to construct and more expensive to maintain. This dominant viewpoint persists despite previous explorative research indicating shifting conceptions about the cost of implementing WMSB in Finland (Riala and Illola 2014, Franzini et al. 2018). On the other hand, attributes related to economic development were strongly favored in WMSB. When examining the ranking of mean values across the 16 attributes (Table 3), the attribute statements ''better for my municipality's brand'' and ''a greater value-added product for domestic industries'' held some of the highest mean values. Furthermore, WMSB were generally believed to be ''better for my municipality's economy'' and to ''contribute more to the economic value of the area''. However, both WMSB and CMSB were, on average, seen to be equally safe financial investments.

Only two of the attributes concerned with economic impacts were associated with background factors. Firstly, the attribute statement ''more expensive to maintain'' correlated with tenure. Respondents with long tenure (15+ years) and short tenure (>1 year), on average, believe that WMSB and CMSB cost the same to maintain. This trend requires further investigation, as tenure length captures only tenure within the current municipality, rather than the respondent's total experience working as a civil servant. Secondly, the attribute statement ''contribute more to the economic value of the area'' was associated with the respondent's municipal geography and previous experience working with WMSB. Civil servants employed in high-population and high-density municipalities (i.e., urban municipalities) believe far less strongly that WMSB contribute more to the economic value of an area. Meanwhile, respondent with previous experience working with WMSB less strongly believed that WMSB improve the economic value of an area. Otherwise, belief about building cost and the other economic attributes held no associations. This begets whether beliefs about cost stem from observation, information, or inference (see: Fishbein and Ajzen 2010, p. 221).

As a final point, WMSB were, on average, considered more beautiful than CMSB. Beliefs about the aesthetics properties of WMSB were impacted by multiple background factors. Respondents occupying detached single-family houses strongly believe that WMSB are more beautiful than CMSB, while respondents occupying multistory buildings held much weaker beliefs. In Finland, detached houses are typically made from wood, while multistory buildings are made from concrete. It is possible that exposure living with these materials creates preferentialism or acclimatization for that material. This is also in line with previous research suggesting a relationship between aesthetic beliefs about a material and previous exposure to said material in the home (Hib et al. 2015). Notwithstanding, it could be argued that the reason why the respondents who believe wood is more beautiful occupy single-family homes is precisely because they appreciate the wooden materials used in these homes.

Beliefs about beauty were also linked to previous experience working with WMSB. Those with previous experience held diminished beliefs about the beauty of

WMSB. This dampening of aesthetic beliefs may reflect that standards of beauty are being checked by personal experience. In this study, the directionality of the relationship (i.e., lower approval for wood as exposure and familiarity increases) is opposite the results from previous studies (Larasatie et al. 2018). Lastly, whether the civil servant was employed in an urban or nonurban municipality also linked to the beliefs about beauty. Employees working for nonurban municipalities believe WMSB to be more beautiful than employees working for urban municipalities. Possibly, urban employees are more familiar with concrete materials due to urban construction; therefore, they do not strongly prefer wood over concrete as a building material.

Limitations

There are some limitations to the study. The representation of the sample group cannot be compared to the target population because no public information exists about age, gender, or professional roles for civil servants working across Finland. Nevertheless, some professional groups (e.g., environmental inspectors) were clearly underrepresented. Additionally, because the target population consists of official public sector representatives, they are especially subject to social desirability bias and nonresponse bias when answering the survey. Nonresponse bias was limited by omitting surveys missing 15% or more of multiple-choice responses. Lastly, the background variables analyzed in this study may not all be independent. The number of cases where attribute statements associating simultaneously with the professional experience and education background factors indicates a co-interaction between these variables; however, other unseen indirect effects may also be occurring.

Future direction and concluding remarks

Civil servants in Finland play an important role in the diffusion of WMSB across the country. Recently, the Ministry of Environment established targets to increase the number of publicly procured residential WMSB at the municipal level, citing construction-sector emissions reduction and support for domestic industries as motivators for the decision (YM 2020b). Nevertheless, WMSB represent a sparse construction trend (PuuInfo2020), thereby indicating a possible mismatch between national directives and local-level objectives. However, the mismatch could not be examined given the limited available information on civil servant perceptions about WMSB (Franzini et al. 2018, Lähtinen et al. 2019).

Determining the beliefs of civil servants about WMSB was a first step towards benchmarking this topic. Notably, the civil servants in this study believe that WMSB have lower carbon dioxide emissions than CMSB, and that WMSB are a greater value-added product for domestic industry. Both of these beliefs align with the justifications presented by the Ministry of Environment for establishing WMSB public procurement targets (YM 2020b). This finding signals a possible match between national government directives and the beliefs of municipal civil servants. Future research should shift towards exploring whether civil servants' beliefs influence the implementation of multistory projects within their municipalities, for example, by analyzing the degree to which the attributes evaluated in this study are important to implementing WMSB projects.

This study also found several background factors to correlate with beliefs about WMSB. This suggests that civil servants within municipal organizations could be subject to internal misalignment about land-use planning objectives if contrasting background factors result in employees having critically different beliefs. For example, profession was central to the formation of beliefs. Real estate managers and building inspectors were revealed to be the most skeptical professional groups, especially concerning the technical and environmental attributes of WMSB. Future research would benefit from deepening the analysis on how background factors shape beliefs, for example, by assessing if co-interactions exist between background factors, or by exploring if professional groups possess underlying values shaping their beliefs. Such research could provide municipalities with the tools to address possible internal misalignment among organizational employees.

Furthermore, because some beliefs—like building cost—held no associated background factors, future research could include background factors unexamined in this research. For example, the role of media and advocacy communication, or the processes of employee socialization within the WMSB business ecosystems both present future avenues of exploration. Alternatively, reimagining the operationalization of the background factors employed in this survey (e.g., knowledge or experience) could also be useful, given the difficulty associated with operationalizing such complex factors. Such research can help to address whether beliefs about the higher cost of WMSB are connected to rhetoric or personal experiences, thereby providing strategies for verifying misconceptions and communicating information among stakeholders.

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