

Comparative Assessment of Consumer Attitudes to Timber as a Construction Material in China and Japan

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Abstract

Timber-framed architecture has a long history in both China and Japan. As an eco-friendly construction material, it is universally acknowledged that the use of timber can be conducive to the achievement of sustainable development for architecture. During the past decades, the development of timber-framed buildings in China and Japan appeared significantly different. Consumers' cognition about timber as a construction material has been widely researched by European academics, while there are few such kinds of studies in China, especially the comparative study between China and Japan. To fill this gap, this study aims to figure out consumers' acceptance and attitudes toward timber used as a construction material in China and Japan. By adopting a structured questionnaire method, this study analyzed consumers' thoughts, knowledge, and awareness of modern timber-framed architecture from the consumer level. The results indicate that Chinese and Japanese consumers have the same prejudices regarding the deficiency of timber-frame houses, in terms of fire resistance, acoustic insulation, and durability, while having positive attitudes regarding health and nature, and doubts about environmentally friendly performance. Moreover, the background developing driving forces and developing obstacles have also been analyzed. These results help to provide a better understanding of the challenges and difficulties that the timber-framed house market is facing in China and Japan. Thus, some suggestions were proposed to policymakers, developers, and timber companies for the future development of timber-structure architecture.

Thirty-nine percent of global carbon emissions are from buildings; 28 percent are generated during a buildings' operational lifetime, with the remaining 11 percent from the process of manufacturing, transportation, construction, and end-of-life stages (World Green Building Council 2019). As global environmental problems become more and more serious, the issues about how to reduce the negative effects of architecture have aroused extensive attention. The words, such as "green design" and "green architectures" have been popular all over the world, and countries try their best to explore new ways to meet the needs of being green, ecological, and low carbon. It is widely recognized that the substitution of timber as a construction material for concrete or steel can effectively reduce carbon emissions (En et al. 2023, Jackson 2023). As an eco-friendly construction material, it is universally acknowledged that the use of timber can be conducive to achieving sustainable development for architecture, and will contribute to the efficiency of carbon emission (Hildebrandt et al. 2017). Timber-structure architecture can provide opportunities for renewability, recycling ability, and

carbon storage that other structural materials cannot (Liu et al. 2016, Luo et al. 2017). In recent decades, following the development of modern timber architecture, timber structural architecture has drawn the attention of more scholars.

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China has a long history of using timber as construction material. The Yingxian timber Pagoda, built in the Liao Dynasty (AD 1056) with a height of 67.31 m, is still the tallest timber building in ancient China, marking the glorious achievement of ancient timber architecture. In the past decades, although the demand for timber buildings has increased with economic development, as well as more efforts being made to improve peoples' living conditions, timber houses still have a low share of the market compared with houses built with other materials (Jing et al. 2017). China is still lagging behind Europe, America, Japan, Australia, and other countries in modern timber construction technology (National Bureau of Statistics of China 2019). Timber is still an uncommon construction material because the path-dependent culture of the construction sector favors well-established traditional materials, such as concrete and steel. Modern timber houses are widely constructed all over the world. In Australia, Canada, Norway, and Sweden, their market shares of timber houses are over 90 percent (Kitek Kuzman and Sandberg 2017, Steinhart et al. 2020, Santana-Sosa and Kovacic 2022). And for Japan, China's nearby neighbor, the market share for timber-frame houses is about 43 percent, (Eastin 2008), while it is around 2 percent in China (Zhang and Fan 2020).

Nowadays, China, the largest developing country in the world, is experiencing unprecedented development, 0.82 million square meters of buildings are under construction and 0.39 million square meters were completed in 2018 (Iwai 2002). From 2017 to 2019, the annual new wood structure construction area of the country was above 2 million square meters, but in 2020, the new construction area of wood structure building fell back to 1.5 million square meters, affected by the policy of small property-rights housing and the COVID-19 epidemic. In 2021, the area of new wood structure buildings was over 3 million square meters, due to the rapid urbanization speed and Chinese determination to reduce carbon emissions in the construction industry.

According to the current development rate of China's construction industry, in 2025 Chinese timber-frame buildings will account for 5 percent of newly built buildings, 20 percent of village buildings, and 50 percent of buildings in tourist scenic areas; the annual timber-framed newly built area can be up to 60 to 80 million square meters. In the coming years, along with a series of new timber construction codes and regulations promulgated and the increasing appeal for reducing carbon emission, the timber-frame-house market is facing huge developing potential.

Japan, a nearby neighbor of China, has a different market situation about the timber-frame-house market. For a long time, timber construction and wood processing technologies were highly developed, even in ancient Japan. In ancient Japan, besides temples and shrines, ordinary houses were built of wood, which is well suited to Japan's humid summer climate, and wooden houses continue to be popular (Iwai 2002). Japan is located at a seismic region, and the ductility of timber joints can react to earthquakes flexibly (Goto et al. 2018). Nowadays, with the highly developed housing industrialization, the market share for timber-structure houses has reached 43 percent in Japan (Eastin 2008). The timber-frame structure system was first introduced in the Building Standard Law (BSL) in 1974, and then the specific design guidelines, "Guideline for designs of wood frame constructions" and "Guideline of the structural calculation of wood frame constructions" were published by

Japan 2 × 4 Home Builders Association with the authorization by the Ministry of Land, Infrastructure, Transport and Tourism (Ministry of Land, Infrastructure, Transport and Tourism [MLIT] 2021). Cross-laminated timber (CLT), a revolutionary engineered-timber product that is widely used for its suitability of prefabrication, fast erection, and better-quality control, has been listed in the BSL since 2016, and a "Manual for design and construction of buildings with CLT panels" has been published by HOWTEC (How Technology) with the authorization by the MLIT (Luo et al. 2017, Goto et al. 2018). Because both forest resources and the wood market differ in China and Japan, consumers are expected to have varied opinions of wood used as a construction material. Actually, the forest resource is one of the most important factors for developing timber-frame houses, and it also has a direct impact on consumers' attitudes (Viholainen et al. 2021). Since 1990s, China's forest resources have achieved substantial changes along with its rapid economic growth. According to the data of the Global Forest Resources Assessment, China's forest area increased from 157.1 million hectares in 1990 to 220 million hectares in 2020 (Food and Agriculture Organization of the United Nations [FAO] 2020a). The rehabilitation of forest land in China has been largely attributed to a series of six national forestry programs that have been implemented since the late 1990s, through which China has planted more than 4 million hectares of forest every year.

During the same period, the percentage of forest cover increased from 16.3 percent in 1990 to 23.04 percent in 2020. Despite the increase, China's forest cover remains considerably lower than the global average level (31% in 2020) (Food and Agriculture Organization of the United Nations [FAO] 2020a). Currently, wood importation into China has increased year by year, from 17.813 million tons in 2014 to 23.052 million tons in 2020 due to the constant development of the Chinese timber-frame house market.

Japan had rich forest resources of 24.9 million hectares in 2020, although Japan is also heavily dependent on imported wood rather than domestic wood resources (FAO 2020b). To a large degree, wood demand in Japan is tied to the housing market, where approximately 43 percent of new homes are framed with wood (Eastin 2008). Japan's major trading partners in timber are the United States, Canada, Russia, Malaysia, Indonesia, Australia, Chile, and Vietnam. More than half of the imported wood fiber is represented by wood chips for paper, while around 30 percent is for construction timber and boards (Ota et al. 2022). The main reason for the large amount of wood imported in Japan is different from China, the low competitive price of domestic wood compared with the foreign wood market (Eastin et al. 2002). The high price of Japanese wood is caused by its inappropriate system for wood production and related industries, such as the narrow and poor condition of forest work roads, lack of human resources such as young workers and forest management professionals, and dispersed sawmilling industries (Hildebrandt et al. 2017). To enhance the competitiveness of Japanese wood products in the domestic construction market, the Japanese government released the Draft 2021 Forest and Forestry Basic Plan in April 2021, which aims to encourage collaboration among Japanese ministries to increase wood utilization in the remodeling and construction of nonresidential buildings.

These differences in forest resources play a role in shaping building traditions and the timber-frame housing market, and

will further cultivate consumers' perceptions about timber used as a construction material. China and Japan have similar traditions and architectural cultures to some extent, but different political, social, and market environments. Additionally, because of the different developing processes of timber-frame houses, forest resources, timber market, and regulations as well as laws, figuring out the attitudes of consumers from these two neighboring Asian countries and analyzing driving forces as well as obstacles to these attitudes' change, would provide invaluable information for construction professionals and decision makers, which could be used as the reference in the future development of timber-frame houses.

For researching timber-frame houses, no matter from the construction technology (Kozlovská 2020, Stehn et al. 2020) or consumers' viewpoint - (Gold and Rubik. 2009, Høibø et al. 2015, Viholainen et al. 2020, Lähtinen et al. 2021), there are few studies in Asian countries. Consumers' cognition about timber as a construction material has attracted widespread attention in European academics, while there are few such kinds of studies in China, especially comparative studies between China and Japan. Therefore, to improve the acceptance of timber-frame houses in the current market environment, and to fill this gap, this study aims to figure out differences in Chinese and Japanese consumers' acceptance and attitudes toward timber used as a construction material. A comparative assessment of the consumers' attitudes about timber as a construction material would provide invaluable information to understand the state of development of the current timber-frame houses from the consumers' level. This research also provides an opportunity to understand how differences in culture between the two countries will affect consumers' attitudes to timber as constructional materials. We aimed to answer the following questions:

1. What are the attitudes of Chinese and Japanese consumers toward using timber as a construction material?
2. What are the underlying driving forces and obstacles relating to changing consumers' attitudes?
3. What are the relative promotion measures in these two countries?

For mastering the answers to the above research questions, this research is structured as follows. Initially, we discuss the research background and relevant literature review to figure out the research objectives and significance. This is followed by the "Research Methodology" section, in which the questionnaire design and the data collection are described. We then present the findings of this research, including consumers' attitudes in China and Japan, driving forces, and obstacles to changing their attitudes. Finally, we present the research conclusion, limitations, and future research directions.

Methodology

In this study, research data were obtained from publicly available sources; secondary literature, such as academic and professional journals, reports, and websites; and a questionnaire investigation. In order to obtain data that can reflect common consumers' perception towards timber as a kind of environmentally beneficial construction material, and their inclination to use timber in a new home build, questionnaires were used to allow for quick distribution and wider coverage, and to increase

the efficiency of data collection and analysis. The data collected with this study can provide an overview on the future potential market for timber used as a construction material, and the potential promoting directions for the future timber housing market in China and Japan.

Variables selection and questionnaire design

The questionnaire shown in the attachment was generated in English and then translated into Chinese and Japanese, and the translation was verified by several native-tongue translators in the targeted language. According to the literature review, hypotheses have been promoted, and the variables in this research are quantifiable and measurable (Table 1).

Attitudes cannot be easily defined. It is an expression of feelings about the objects and also describes the consumer's confidence in the various attributes and benefits of such objects (Fishbein et al. 1980). Consumer attitudes vary from person to person due to some internal factors like different psychological and emotional reactions and external factors like family preference and social as well as cultural status. Generally, socio-demographic characteristics have effects on consumers' attitudes to products. (Katt and Meixner 2020).

Attitudes towards timber-frame houses will be directly influenced by consumers' beliefs and demographics. In this study, socio-demographic characteristics, such as gender, age, and occupation have been selected as variables. Moreover, consumers' beliefs and experiences also have vital effects on consumer-driven business strategies. (Aboulnaga and Elsharkawy 2022). Environmental awareness is an important driver for the development of innovative forest-based products (Sandra and Alessandro 2021). Additionally, current purchases and knowledge also have vital effects on the consumers' willingness of future purchases (Wang et al. 2017, Jung et al. 2020).

The current purchase patterns, knowledge, and consumers' environmental awareness are all important factors that will influence consumers' attitudes toward timber-frame houses. Therefore, factors are determined by the paths shown in Figure 1, which leads to the formation of overall attitude toward timber-frame houses, including factors such as customers' knowledge and information, current house purchase patterns, beliefs about timber-frame houses, environmental awareness, personal background such as demographics and socio-economic factors. This model is an extension of the multi-attribute and mediation models of Moon, Ajzen, and Fishbein (Moon and Balasubramanian 2004).

Based on the factors proposed for determining consumer attitudes, the questionnaire has been divided into three sections: the first section is demographic information, including gender, age, location, and occupation. The second part of the questionnaire directs the respondents to check their attitudes towards timber-frame houses. Three detailed questions are designed to get their personal experience with timber-frame houses.

Moreover, there are two tables designed in this part. The first table is to check consumers' current purchase patterns to evaluate which aspects are decisive for the choice of a certain building construction mode. The second table was designed to show the attitudes towards timber as a construction material. Several typical attributes, including the most essential characteristics of the timber, such as cost, fire resistance, cozy living, acoustic insulation, health, security, aesthetics,

Table 1.—Hypothesis.

H1: Gender variable affects on the attitudes when consumers do the housing purchase.
H2: Gender variable affects on the attitudes when consumers do evaluation on timber frame houses.
H3: Personal experience variable affects on the attitudes when consumers do the housing purchase.
H4: Personal experience variable affects on the attitudes when consumers do the evaluation.
H5: Age variable affects on the attitudes when consumers do the housing purchase.
H6: Age variable affects on the attitudes when consumers do the evaluation on timber frame houses.
H7: Occupation variable affects on the attitudes when consumers do the housing purchase.
H8: Occupation variable affects on the attitudes when consumers do the evaluation on timber frame houses.

modernity, and so on, could be chosen to measure the attitudes, as shown in Figure 2.

In this part, two 4-point scales are used: they are 1 (agreeing fully), 2 (agreeing somewhat), 3 (disagreeing somewhat), and 4 (fully disagreeing); or 1 (very important), 2 (important), 3 (unimportant), and 4 (not important at all). The third part of the questionnaire was designed to check consumers’ environmental awareness, their belief about the future construction materials, and their interest in timber-frame houses.

Data collection and handling

In order to obtain objective and comprehensive data in this study, a questionnaire was designed and used to collect data, which is the most popular and oldest form of survey data collection. Before the questionnaire was distributed, it was pre-tested with a small number of people before mass distribution. The pilot test was designed and sent to four professors who come from two universities and have wide experience with public surveys. Additionally, the pilot test was also sent to 20 individuals to check that the questionnaire was accurate, descriptive, and understandable. Based on their input, the questionnaire was further revised to make sure that there were no reading problems, and that it was understandable and reasonable for respondents.

We determined that the respondents in this study should be over 18 years old. That’s because citizens over 18 years old in China are more mature, and socially defined as adults who have the right to vote and to be elected (Kozlovská 2020). Besides their age, we determined that respondents should own houses or would buy houses in the near future. Prior to data analysis, questionnaires with invalid responses, missing data, and outliers were removed. The inclusion criteria were individuals who (1) were at least 18 years old, (2) able to read and complete the questionnaire independently, and (3) voluntarily agreed to participate in the survey. To prevent missing data, if the participant began to fill out the questionnaire but did not complete it, we considered it invalid. Respondents had to finish all questions to be able to submit their survey. There was no time limit for completing it.

The data were collected from April to May 2020 in China by a Chinese data collection website named Jin Shu Ju. The online anonymous questionnaire was distributed using the “snowball method” (Jacobsen 2005) via a link embedded in several social networks such as WeChat, a Chinese public communication app, and an email or message sent to friends, family, and work colleagues to enable participants to answer and submit at their convenience and to maintain their anonymity. Based on our research status and the previous comparative research literature (Bonnell 2003, Dyson et al. 2021, Piccitto et al 2022, Bosshard et al. 2023). This study uses data from two commonly used data collection methods in China and Japan respectively. The data collection in Japan was conducted from November and December 2020 in Kitakyushu, Japan; the questionnaire was given to the respondents face-to-face. During this period, there were several festival events, which attracted a variety of residents. We chose to distribute our questionnaire near train stations, bus stops, and the events’ locations, which could ensure the number of participants and their diversity. The questionnaires were distributed to participants with a paid postal envelope and a restaurant voucher, which increased the response rate (Frederiks et al. 2020).

As a result, a total of 287 Chinese responses were received after the follow-up mailing, and from the data collection website; the response rate was approximately 65 percent.

In Japan, 236 completed questionnaires were collected, and the response rate was approximately 80 percent. Both the response rates can be considered satisfactory compared to other studies based on a questionnaire survey administered to a sample of consumers (Sandra and Alessandro 2021). Prior to analysis, the collected responses were transformed via Excel into an SPSS readable form. Analyses were conducted through SPSS (Ver. 22) statistical software. Common correlations, factor analytic stability of the dimensional, and analysis of variance (ANOVA) testing of the resulting differences were applied.

Results

Descriptive analysis results

The demographic properties of the two countries’ respondents differ in many ways, whereas some similarities have been found in the results. The results of the demographic distribution of China and Japan are shown in Table 2. Chinese respondents included a higher percentage of females than Japanese respondents. For the age distribution, both the majority of Chinese and Japanese respondents were between 18 and 40, while for the age over 60, Japanese respondents were more numerous. Population aging is an urgent problem faced by many countries in the world, and in Japan, the proportion of elderly people in Japan is estimated over 26 percent, which is a larger number

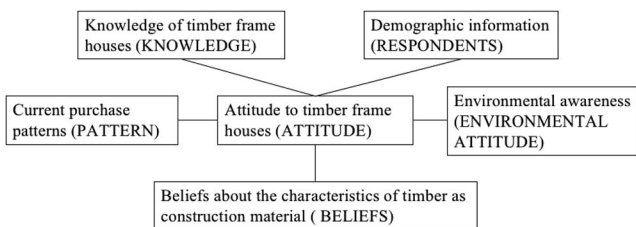


Figure 1.—Causal relationships between factors proposed to determine the attitudes of respondents.

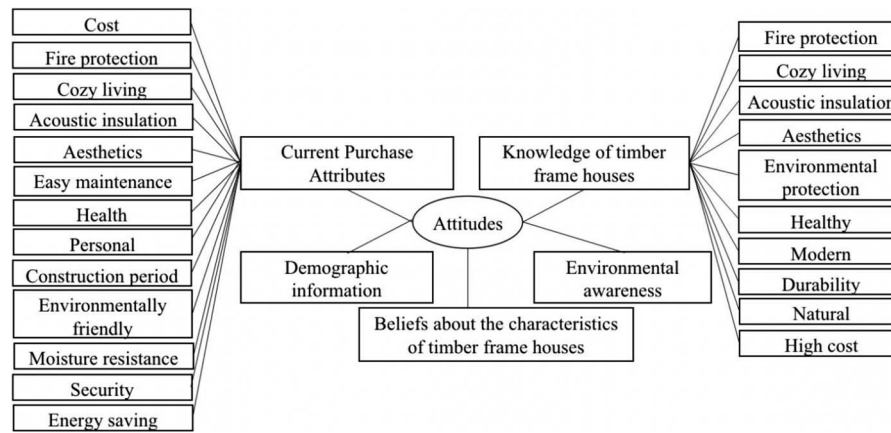


Figure 2.—Details of questions in the questionnaire.

than in any other country in the world (Liu et al. 2016). The age distribution of this investigation also reflects the current Japanese population situation. Compared with Chinese consumers, Japanese consumers for housing purchase are older.

Analysis of the different assessments and attitudes toward timber-frame houses between China and Japan

Similarities and differences were found after the analysis of answers from both Chinese and Japanese respondents. Actually, a buying decision is a multi-dimensional process with many different factors affecting it. Here in this paper, just some factors that are characteristic of timber-frame houses were picked out. After doing the comparison, Table 3 shows that the top three factors that Chinese respondents pay more attention to are health, cozy living, and security, while cozy living, fire resistance, and acoustic insulation are the top three important factors that Japanese respondents pay more attention to. The least attention shown by Chinese respondents is the short construction period, aesthetics, and easy personal contribution, and Japanese respondents' pay least attention to

easy personal contribution, short construction period, and environmentally friendly materials. Moreover, the Chinese and Japanese respondents have the same attitudes towards maintenance and energy saving, while there is a big difference in costs.

Following the analyses of house purchase patterns, a list of attributes embracing the most essentially perceived characteristics of timber-frame houses was compiled in order to measure the attitudes of consumers towards timber as a construction material. The respondents were asked to which extent they considered that timber held these attributes. They had the choice among agreeing fully, agreeing somewhat, disagreeing somewhat, and fully disagreeing.

After the analysis of both Chinese and Japanese surveys, Table 4 shows the result: (1) Nature, health, and high cost are the top three attributes of timber as construction materials that Chinese respondents hold positive attitudes on, and ventilation, health and cozy living are the top three attributes that Japanese respondents' hold positive attitudes on. (2) More Chinese respondents hold doubts about ventilation, environmentally friendly materials, and cozy living. And more Japanese respondents hold doubts about nature, environmentally friendly materials, durability and acoustic insulation. (3) From Chinese respondents the assertions about timber's durability, acoustic insulation and fire resistance are strongly rejected, while for Japanese respondents are high cost, fire resistance, and modernity are three attributes strongly rejected.

The use of timber as a construction material is highly valued by consumers, since it is specifically considered to be healthy and provide optimum of living comfort as well as being generally estimated to be a suitable construction material (Blackwell et al. 2006). Therefore, it can be summarized that health and nature are the widely accepted attributes by both Chinese and Japanese respondents. However, for the environmentally friendly materials, respondents from both countries showed their doubts. For the high cost, consumers show a big difference: Chinese consumers agree that timber frame houses are high cost, while the Japanese show less agreement. Four attributes—fire resistance, acoustic insulation, durability, and modernity—are strongly rejected by both Chinese and Japanese respondents.

In order to check the relationship between age, gender, and occupation with their attitudes on the timber used as construction material, a *t* test independent samples test and 1-way ANOVA were adopted to do the analysis. According

Table 2.—Demographic information.

Variables	Frequency (%)	
	China (n=287)	Japan (n=236)
Gender		
Male	36.5	58.8
Female	62.9	41.2
Unknown	0.6	0
Age		
18–30	44.3	64
31–40	31.5	5.1
41–50	11.1	7.4
51–60	12.5	12.5
61–70	0	4.4
Over 70	0	2.2
Occupation		
Civil servant	14.1	5.9
Student	13.6	58.8
Office staff	38.3	14.0
Freelancer	10.2	2.2
Self-employed	5.5	1.5
Housewife	0	6.6
Others	17.5	10.3

Table 3.—Chinese and Japanese respondents' assessment on purchasing building construction model.

Variables	China (n=287)			Japan (n=236)		
	Mean	St.dev	Rank	Mean	St.dev	Rank
Health	1.14	0.383	1	1.66	0.793	5
Cozy living	1.2	0.434	2	1.37	0.570	1
Security	1.27	0.514	3	1.68	0.795	6
Fire resistance	1.31	0.58	4	1.58	0.726	2
Moisture resistance	1.32	0.528	5	1.79	0.793	7
Acoustic insulation	1.33	0.518	6	1.58	0.726	3
Environmentally friendly	1.49	0.628	7	2.27	0.962	11
Cost	1.51	0.571	8	1.65	0.783	4
Maintenance	1.53	0.625	9	2.10	0.828	9
Energy saving	1.71	0.631	10	2.11	0.971	10
Easy personal contribution	1.91	0.694	11	3.12	1.440	13
Aesthetics	1.93	0.676	12	2.06	1.140	8
Short construction period	2.14	0.728	13	2.81	1.255	12

Question: How important do you consider the following issues when you decide on purchasing the building construction model?

Source: own illustration.

1. Scale from 1 represents positive attitude and 4 represents negative attitude.
2. Mean of all evaluations for one item (codes 1 to 4): the smallest the average, the more important the aspect with regard to the decision for a certain building construction mode.

to the analysis results shown in Table 5, it was found that six factors receive significant differences ($P \leq 0.05$) in China, which are fire resistance, cozy living, acoustic insulation, environmental protection, health, and durability; respondents between ages 41 and 50 show the highest agreement on timber-frame houses or the use of timber as construction materials, while the younger respondents show lower agreement and doubt on these factors. Hence, Hypotheses 5 and 6 are supported. The younger respondents saw timber construction as “old-fashioned” and “low quality” (Su et al. 2012). Young consumers between 18 to 30 years of age are the main consumers with a high probability of becoming future home buyers. Therefore, improving young consumers' perception of using wood as construction material should be paid more attention in future marketing promotion.

Different from China, in Japan, three factors—energy saving, easy personal contribution, and cost—were figured out to have a significant difference and the age distribution was much scattered. Hypotheses 1 and 2 are supported among Japanese consumers, but cannot be supported in Chinese consumers. For different genders, it is found that there is no difference on their attitudes in China, while in Japanese female consumers show more agreement on using timber as construction materials. Among the different occupations, Chinese civil servants show more agreement on the characteristics of cozy living, acoustic insulation, and durability, and the self-employed show agreement on timber-frame houses for their modernity. In Japan, five factors figured: they are security, health, environmental protection, maintenance, and energy saving; the occupational differences are also different from Chinese consumers. Students show more agreement on security, housewives think that timber houses are healthy, civil servants agree on the characteristics of environmental protection and maintenance, and the self-employed show more agreement on energy saving. This difference supports Hypotheses 7 and 8.

Table 4.—Chinese and Japanese respondents' assessment on timber used as a construction material.

Variables	China (n=287)			Japan (n=236)		
	Mean	St.dev	Rank	Mean	St.dev	Rank
Natural	1.14	0.389	1	1.67	0.667	4
Healthy	1.22	0.139	2	1.74	0.834	2
High cost	1.27	0.467	3	2.33	1.086	8
Environmental protection	1.36	0.587	4	2.00	0.911	5
Ventilation	1.37	0.586	5	1.67	0.667	1
Cozy living	1.39	0.515	6	1.84	0.880	3
Modern	1.69	0.595	7	2.90	1.186	10
Durability	1.79	0.662	8	2.09	1.085	6
Acoustic insulation	1.83	0.686	9	2.33	1.123	7
Fire resistance	2.03	0.773	10	2.70	1.085	9

Question: To which extents do you agree with the following statement: timber as a construction material is.....

Source: own illustration.

1. Scale from 1 represents positive attitude and 4 represents negative attitude.
2. Mean of all evaluations for one item (codes 1 to 4): the smallest the average, the more positive attitudes to timber used as a construction material

Comparison of knowledge of, belief in, and interest in timber-frame houses

Individual factors, also called internal factors, refer to the consumers' psychological processes that affect consumer behavior. Personal influences involve consumer demographics, personality, lifestyle, motivation, knowledge, intention, beliefs, and feelings (Wu 2003). Personal living experiences, as one way to get knowledge, belief and interest, and whether the respondents have the experience of living in a timber-frame house were asked. The analysis result shows that the living experience is similar for both Chinese and Japanese respondents: 53.8 percent of Chinese respondents and 56.6 percent of Japanese respondents have experience lived in timber-frame houses before, shown in Figure 3. There were no big differences in the personal living experience and no difference was detected in consumers' attitudes towards timber-frame houses. Hence, Hypotheses 3 and 4 cannot be supported.

Timber, as a recyclable construction material, will play an important role in reducing the pollution from the construction field. A question asked interviewees about whether they know about low-carbon society or climate change, Figure 4. The aim of this question is to attempt to figure out whether there is a relationship between environmental awareness and attitudes toward timber-frame houses. A 1-way ANOVA was used to check the relationship between environmental awareness and attributes toward timber-frame houses; the mean difference is significant at the 0.05 level ($P \leq 0.05$). After analysis, it was found that environmental awareness does not have a close relationship with people's attitudes toward timber-frame houses. For Chinese respondents, cozy living and health are the two attributes that have differences for differing environmental awareness. For Japanese respondents, the results show that just cozy living is different among the respondents' own different environmental awareness ($P \leq 0.05$). Consumers with higher environmental consciousness, on the one hand, tend to support timber as construction material to reduce the carbon emission caused by architecture; on the other hand, lots of people are aware that trees are essential for maintaining equilibrium within the natural environment and worry about environmental problems such as deforestation. Indeed, trees

Table 5.—T-test independent samples test and One way ANOVA to summarize the different attitudes for the evaluation of timber frame houses.

	China				Japan				
	Factors		Mean	Sig.	Factors		Mean	Sig.	
Age	Fire resistance	41–50	1.74	0.000	Energy saving	51–60	0.668	0.003	
	Cozy living	41–50	1.16	0.000	Easy personal contribution cost	31–40	2.29	0.050	
	Acoustic insulation	41–50	1.52	0.000		61–70	1.33	0.023	
	Environmental protection	41–50	1.22	0.027					
	Health	41–50	1.10	0.009					
	Durability	41–50	1.11	0.000					
Gender	There are no attitude difference between genders.				High cost	M	2.49	0.027	
					F	2.09			
Occupation	Cozy living	Civil servant	1.25	0.046	Security	Student	0.68	0.008	
	Acoustic insulation	Civil servant	1.67	0.006	Health	Housewife	1.11	0.333	
	Modern	Self-employed	1.52	0.013	Environmental protection	Civil servant	1.38	0.001	
	Durability	Civil servant		1.58	0.002	Maintenance	Civil servant	1.88	0.021
						Energy saving	Self-employed	1.50	0.040

can act as a net consumer of CO₂, or carbon sink, during their growing time (Brienen et al. 2020). However, once trees become mature, they absorb far less carbon, so reasonable harvesting is necessary. If the wood is managed properly as in planted forests, it could be associated with a good image of a sustainable material.

Figure 5 shows that both Chinese and Japanese respondents have high interest in timber-frame houses. According to the content design of the questionnaire, the question “Are you interested in timber-frame houses?” means “Do you want to know information about timber frame houses in the future?” For further analysis, a 1-way ANOVA was used to check the relationship between consumers’ interest and their purchase patterns as well as their evaluations of the attributes of timber-frame houses. The analysis result shows that $P \leq 0.05$, which means there are relationships between the consumers’ interests and their purchase patterns, as well as their evaluations. Therefore, for the long term of promoting timber-frame houses, it is necessary to improve young consumers’ consciousness and interests through education and media promotion.

Discussion

What are the attitudes of Chinese and Japanese consumers towards timber as a construction material?

Due to the mature market for timber-frame houses and the higher market proportion, it is assumed that Japanese consumers

have higher levels of knowledge, experience, interest and agreement about whether timber can be widely used in construction versus Chinese consumers, whereas the research results indicate that Chinese and Japanese consumers have almost the same experience. This may be because timber-frame houses are still fresh and notable in China, and it is impressive and memorable once consumers have experience (Luo et al. 2018). From the statistical results, compared with Japanese consumers, the Chinese are more familiar with low-carbon society or climate change, while the Japanese show higher interests in timber-frame houses. In recent years, many Chinese cities have made efforts to construct a low-carbon city and a low-carbon society (Su et al. 2003). Thus, Chinese consumers get a lot of information about this. As mentioned above, timber-frame houses in Japan account for a much higher proportion, and the detached single-family house is common, from 41.3 percent in big cities to 54.8 percent in smaller cities (Wu 2003). However, the living situation in China is significantly different; the commonest residence form is a multi-floor apartment built with concrete and steel structures. Thus, when mentioned purchasing houses or attitudes toward timber-frame houses, the Japanese show higher interests, while the Chinese thought that owning a timber-frame house would be a distant possibility.

Chinese experts considered the price and the reputation of the residential area as the two most important criteria for the public when deciding to purchase a house (En et al. 2023). However, this research indicates that Chinese consumers consider health, cozy living, and security to be the

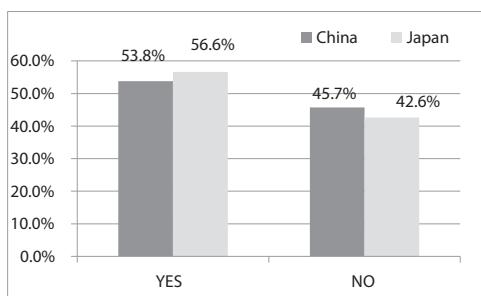


Figure 3.—Respondent’s answers to the question “Do you have previous experience living in timber houses?”

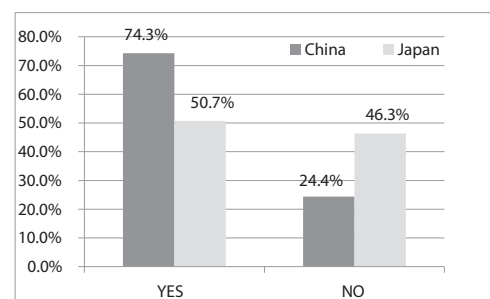


Figure 4.—Percentage of the respondents answers to the question “Do you have previous information about low-carbon society or climate change?”

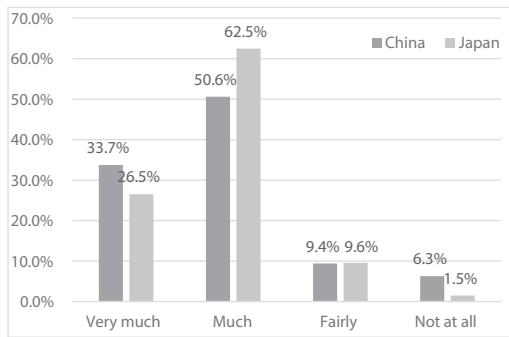


Figure 5.—Percentages of Chinese and Japanese respondents' answers to the question "Are you interested in timber-frame houses?"

top three criteria when deciding to purchase a house. In addition, Japanese consumers pay more attentions to cozy living, fire resistance, and acoustic insulation. This may be due to different cultural backgrounds and status quo in respective marketplaces: in Japan, timber-frame houses are very common, and the negative attitudes of being easily flammable and having low fire performance come to be long-term solidified perceptions, thus features that the Japanese pay much more attention to. The concern for acoustic insulation is influenced by Japanese culture: do not disturb others. It is common to find out that Japanese people are used to keeping voices low in lots of occasions compared with other countries. Thus they take acoustic insulation as one of the important factors for housing purchases. Actually, the previous experiment shows that the actual air sound insulation of timber-building partition walls and floor slabs is 50 dB and 52 dB, which basically equal to the level of sound insulation performance of concrete buildings (Martins et al. 2015).

For knowledge and agreements regarding timber used as a construction material, both Chinese and Japanese consumers have the same attitude on the attributes of health, nature, environmental protection, durability, acoustic insulation, and fire resistance, while for the attributes of high cost, modernity and ventilation, they showed significant differences. Compared with the Japanese, the Chinese stated that timber-frame houses have a high cost. As mentioned above, timber-frame houses are not common and still new in the architectural market. Timber is mostly used in villas and some public architecture, which will give common consumers the impression that timber-frame houses have high cost, and it is also one of the reasons why timber-frame houses have low market acceptance in China. Unlike the Japanese, Chinese consumers show higher agreement on the characteristics of modernity, whereas the Japanese show the lowest agreement on this among the 10 typical characteristics of timber-framed houses. One possible reason is that timber-frame houses are at their introductory stage in China; what consumers look at are the modern and new, well-built architecture. However, after decades of development, the number of timber-frame houses in Japan are relatively high, 56.9 percent in 2018 (Statistics Bureau 2022). In Japanese respondents, the impression is that timber-frame houses no longer stand for modernity, but are outdated.

Therefore, in order to improve the acceptance of timber-frame houses in current market environment, the misunderstandings about timber-frame houses summarized above should be changed; the knowledge, properties, and benefits need to be promoted by education and media promotion. Among these two countries, China should make much more effort for educating consumers, because the Chinese market is still in the introductory stage. For a long-term promotion of timber-frame houses, it is necessary to do education and media promotion among young consumers, who will be potential house purchasers in the near future.

What are the underlying driving forces relating to changing consumers' attitudes?

Driving forces: construction market and developing process.—Both China and Japan have a long history of using timber as a construction material. However, due to the different development processes and distinct domestic situations, the current situations of timber-structure architecture in these two countries are very different. In China, the research and application of timber-frame houses has been stagnant for decades in the last century until the end of the 1990s, when the importation of North American light timber-constructed houses, the use of timber as a construction material start to develop. According to the National Ministry of Housing and Construction plans during the "13th Five-Year Plan" period, by 2020, timber-frame buildings would strive to reach 5 percent of the building market, which is currently less than 1 percent (The First China Green Timber Industry Conference and the Ninth China Timber Protection Industry Conference in Suzhou, 2016). This will be a further impetus for the rapid development of modern timber construction in China. With the rapid urbanization of China, fast-expanding cities, and skyrocketing realty prices, apartment buildings have been built and sold without official permission, professional designs, and quality control; the sale and purchase of such apartments are illegal. What is worse is that people who buy them cannot get any ownership certificate from the state. They are called "houses with limited property rights," which have been developed rapidly during 2010 to 2013. However, the development of houses with limited property rights was limited by a national policy in 2015. The construction of timber-frame houses had to shift the market center from residential buildings to cultural and tourism real estate. From 2014 to 2018, the market created income from 127.1 billion renminbi (RMB) to 174.4 billion RMB, and the annual growth rate was 8.2 percent. Along with the rapid development of Chinese culture and tourism, the market for timber-frame houses is expected to be 289.3 billion RMB in 2023 (Tang, H. B., 2019). Another driving force for developing timber frame houses is the Chinese rural revitalization. In 2015, among the newly built timber-frame houses in towns, 47 percent were residential houses, 43 percent were public buildings, and 10 percent were temporary buildings (Iwai 2012).

In Japan, according to the Ministry of Land, Infrastructure, Transport and Tourism of Japan, the proportion of wood-frame buildings in all new residential buildings increased year by year during the past 20 years. In 2020, the proportion of wood-frame buildings in nonresidential buildings was 9.0 percent, 83.3 percent in low-rise houses, and 88.0 percent in one- and two-story houses (MLIT 2019). According to

the National Survey in 2019, when asked about residential purchase inclinations, 73.6 percent of respondents chose timber-frame houses (MLIT 2019). All in all, the Chinese rapid development of timber-frame houses and the Japanese high market proportion will have long-term effects on consumers' perceptions and attitudes towards timber used as a construction material.

Driving forces: standards and design codes.—Standards and design codes are necessary to guarantee the desired safety and performance of structures and are one of the most important driving forces for promoting timber-frame houses. Concerning timber structures, the development of the standards and design codes between China and Japan are significantly different, as shown in Figure 6. Along with the improvement of relevant standards and design codes, timber used as a construction material will be promoted rapidly, and consumers' attitudes will be changed with the development of timber-frame house standards and codes.

Figure 6 illustrates the historical overview of the laws and regulations on timber-frame houses in Japan and China; it shows that Japan has a longer history of timber-frame house development, especially in the 1980s. The development of laws and regulations in China is relatively late, mainly after 2000, but it has been accelerated in recent years. Additionally, in 2017, there was a series of new regulations or standards implemented in China, such as the Technical Standard for Assembled Timber Buildings in January 2017 formulated by the Ministry of Housing and Urban–Rural Development, which regulates the design, production, construction, and acceptance standards of assembled wood buildings; the “Design Standards for

Wood Structures” was also formulated in November 2017 to regulate the grading of wood materials and strength levels, supplement the design regulations for square log structures and combined wood structures, and improve the design regulations for glued wood structures and light wood structures. In October 2017, the Ministry of Housing and Urban–Rural Development formulated the Technical Standards for Multi-High-Rise Timber Buildings to clarify the concepts related to multi-high-rise timber buildings and to develop as well as improve the design, fabrication, installation, and maintenance procedures.

Driving forces: forestry.—The tree cover percentage in China is about 23 percent, but it is more than 65 percent in Japan. In China, the forest coverage ratio is still far below the global average. The main reason for the current high cost of timber-frame houses and low market proportion is that the timber is dependent on imports. It is important for the Chinese government to implement an efficient forest management strategy to find the balance between utilizing timber as a construction material, realizing the ambition that the Chinese government has set in environmental sustainability, and ensuring the forest area coverage remains in its upward trend (Liu et al. 2016). In China, after the development of wood processing, timber reserve yield and reserve have relatively increased. However, the forest coverage in China is not in balance and also is low, and it should be improved by the reasonable planning of forest development. Actually, Chinese forest area and forest stock have expanded rapidly from 122 million hectares and 866 million cubic meters in 1978 to about 231 million hectares and 1949 million cubic meters in 2022. New forest plantations were a

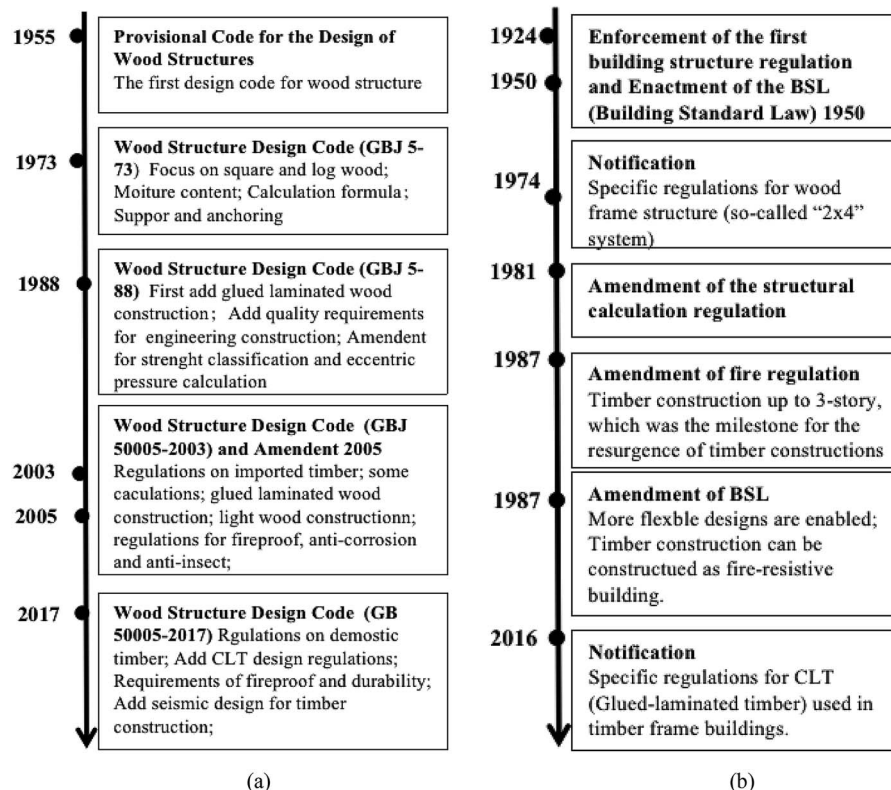


Figure 6.—The historical overview of laws and regulations about timber construction in China and Japan: (a) China (b) Japan.

large part of the growth, increasing from 24 million hectares in 1978 to 383 million hectares in 2022. From 1978 to 2023, China's forest coverage rate increased by more than 10 percentage points, the fastest in the world.

Thus, how to ensure enough timber supply will act as one of the critical factors that influence the future development of timber-frame houses. Moreover, timber-frame houses can be prefabricated. The improvement of timber-frame house industrialization will promote further development of the Chinese housing market. The situation in Japan is different from China; the forest reserve has increased 2.8 times over what it was 50 years ago, and now it is about 249.4 million hectares. However, the self-sufficiency ratio of wood is only 35 percent. This is due to the high cost and low efficiency of forest management and timber production, while imported timbers are cost competitive (Goto et al. 2018). Therefore, in order to make the forestry and forest-based industry of Japan more sustainable, the Japanese government has been putting a large effort toward increasing the use of wood in recent years and has focused exclusively on growing its domestic forestry and wood processing industries through a myriad of subsidy programs and regulatory frameworks including tax advantages and financial support (Eastin et al. 2002).

Japan promotes the use of lower-quality wood from forest areas where the management is insufficient due to economic difficulty. Among various types of wood-based construction materials, CLT is expected to play an invaluable role in the utilization of domestic wood resources. In fact, CLT has been listed as a general construction material in the Japanese building code since April 2016, and the volume of CLT usage has been gradually increasing. Japanese wooden-building companies should also emphasize market segmentation and product differentiation (Luo et al. 2017).

Conclusion

Both China and Japan, two neighboring Asian countries, are famous for their timber-frame houses in history, while their present timber-frame house markets are significantly different. This paper analyzes the differences in Chinese and Japanese consumers' perceptions towards timber used as a construction material and figures out the underlying driving forces and obstacles relating to changing consumers' attitudes.

In this paper, we first discuss the consumers' housing purchase situations, then consumers' perceptions toward 10 typical characteristics of timber, and the relationship between consumer attitudes and their demographic differences; finally, we further researched the underlying driving forces and obstacles in both China and Japan. In this study, it is found that Chinese consumers show high interest in timber-frame houses even timber-frame architecture takes a very low market proportion in China. Moreover, Chinese consumers also show high agreement on the performance of the timber when it is used as construction materials. However, there are still biases in both China and Japan due to the lack of adequate knowledge and awareness. They assume the performances of present timber-frame houses to be the same as traditional wooden structures, and consider that all wooden structures have safety problems, such as corrosion issues and fire resistance, and are structurally unstable. In addition, it is generally considered that because of insufficient forest resources and land resources, and large urban population density, the market for developing timber frame houses is very limited (MLIT 2019). Thus, in order to improve

the acceptance of timber frame houses in the current market environment, these misunderstandings about timber-frame houses should be changed, and the knowledge, properties, and benefits of timber frame houses need to be promoted by education and media promotion. Among these two countries, China should make much more effort for educating consumers, because the Chinese market is still in an introductory stage. For the long-term promotion of timber-frame houses, it is necessary to improve young consumers' consciousness by education and media promotion, because they will be the potential house purchasers in the near future.

This study has identified some characteristics of attitudes of Chinese and Japanese consumers towards timber-frame houses and timber used as construction material, and we have figured out some similarities and differences among them, but there are still some limitations. The main limitation of this research is the data collection. In this study, quantitatively evaluated questionnaire distribution was selected as a method of collecting and analyzing data. However, some of the respondents doubted the purpose of the investigation and were reluctant to reveal their true attitudes. We used online panels to do the survey in China, and this method has its limitations. For example, the requirements of internet access have limited the ability of some people to take part in this investigation, and the risk of low-quality data was also generated by unmotivated respondents who provided false answers or answered too fast (Viholainen et al. 2021). Another limitation is the fact that we did not pay more attention to cultural differences and living habits between China and Japan. Actually, different national contexts, social and cultural backgrounds, and living habits would affect consumers' housing purchase patterns and evaluation on timber as construction material. Therefore, future studies for promoting timber-frame houses in China and Japan should conduct more analysis based on different cultures and social backgrounds. The consume-attitudes investigation should also be designed according to different national contexts. Considering the further promotion timber-frame houses, new architectural technologies and policy analysis should be systematically researched. Moreover, the cross-country results presented in this paper pave the way to conduct large-scale research among more countries on consumers' attitudes towards timber used as a construction material.

Acknowledgment

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Questionnaire

Dear Respondent,

This questionnaire is designed solely to carry out comparative investigations on the Chinese and Japanese consumers' attitudes towards wood used as an architectural material for research in architecture at the University of Kitakyushu, Japan. We truly appreciate your cooperation in completing the questionnaire. All information provided will be treated with strict confidentiality.

Part A: Personal Information

1. Gender Male Female
2. Age.....years
3. Educational Background
 - Primary Secondary High School Professional school
 - Undergraduate Graduated Other, please specify:.....
 - Civil servant Freelancer Unemployed
 - Business owner Student Retired/housewife
 - Private company officer Other, please specify:.....

Part B: Attitudes towards timber as a construction material

1. Do you have experience living in timber houses before?
 - Yes No
2. If yes, please state that whether you like it or not?
 - Very much Much Fairly A little Not at all

Topics	Very important	Important	Unimportant	Not important at all
Low costs	1	2	3	4
Fire resistance	1	2	3	4
Cozy living comfort	1	2	3	4
Acoustic insulation	1	2	3	4
Aesthetics and visual appearance	1	2	3	4
Easy maintenance	1	2	3	4
Health aspects (allergies, quality of room air)	1	2	3	4
Easy personal contribution	1	2	3	4
Stability and quality	1	2	3	4
Short construction period	1	2	3	4
Environmentally friendly materials	1	2	3	4
Reputation of the residential area	1	2	3	4
Safety against theft	1	2	3	4
Energy saving	1	2	3	4
Flood safety	1	2	3	4
Surroundings of the residential area	1	2	3	4
Location close to the working place	1	2	3	4

3. If there is a choice, between a concrete house and a timber house, will you choose a timber house?
 - Yes No

Topics	Agree fully	Agree somewhat	Disagree somewhat	Fully disagree
Expensive	1	2	3	4
Fire resistant	1	2	3	4
Cozy	1	2	3	4
Acoustic insulation	1	2	3	4
Aesthetics	1	2	3	4
Eco-friendly	1	2	3	4
Healthy	1	2	3	4
Modern	1	2	3	4
Stability	1	2	3	4
Longevity	1	2	3	4

4. How important do you consider the following issues when you decide on the building construction model? Please circle the number to indicate your opinion with the following statements:

5. To which extent do you agree with the following statement: Timber as construction materials is. . .
Please circle the number to indicate yours opinion with the following statements:

Part C: Attitudes towards low-carbon society

1. Did you know information about low-carbon society or climate change before?

Yes No

2. If yes, please state the kind of information source.

TV Radio Journal/Publication

Seminar/training Newspaper Poster

Local government Website Other, please specify:

3. Are you interested in low-carbon society or climate change information?

Very much Much Fairly Not at all

4. Do you think timber-structure architectures can improve the Chinese environment and speed up its low-carbon society development process?

Yes No

5. What do you think will be the main construction materials for future housing in China?

Mainly wood or bamboo Concrete Concrete, brick, and wood

Concrete, wood, and bamboo

6. Are you interested in timber houses?

Very much Much Fairly Not at all