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Consumer willingness to pay for modern wooden structures: A comparison between China and Japan

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ABSTRACT

The use of timber materials in construction has a long history in Asian countries, especially China and Japan. Wood, as an eco-friendly construction material, can play an important role in sustainable development. During past decades, the early modern and modern wooden structural industry in Japan has developed rapidly, compared with that in China; this difference is due to the distinct domestic situations of the two countries, which involve forest resources, timber imports and exports, forestry industrial development, government policies, and geographical factors. This study analyzed the modern wooden structure market at the consumer level in Japan and China, given their different market environments. The results show that Japanese consumers have a higher premium acceptance for modern wooden structure residences, whereas Chinese consumers are more willing to pay for modern wooden structure hotels. Several factors were examined as determinants of consumers' willingness to pay for modern wooden hotels and residences. The results indicate that, for modern wooden hotels, affection and prior experience influence both Japanese and Chinese consumers' willingness to pay price premiums, while education negatively impacts the likelihood of paying a premium for modern wooden structure hotels in China. For modern wooden residences, only affective factors increase the likelihood of paying a premium in both China and Japan; moreover, prior experience, positive knowledge, and household size have negative effects on it in China. Compared with cognitive and demographic factors, affective components influence consumers' willingness to pay for modern wooden structures strongly. These results help to provide a better understanding of the modern wooden structure market in Japan and China, and we offer suggestions to policy makers, developers and timber companies regarding modern wooden structure promotions.

1. Introduction

China has a long history of using timber as a construction material. Early appearances of wooden structures date back over 3000 years. Ancient Chinese applied Sunmao (mortise and tenon joint structures) in wooden structural buildings, and developed the traditional Chinese style wooden structure into an integrated construction system, which has been spread widely in neighboring countries, such as Japan and Korea. Traditional Chinese wooden structures were used commonly in several types of construction, such as palaces, temples, and residential buildings.

However, after the founding of the People's Republic China, to protect forest resources, Chinese government once restricted to the use of wood as a construction material and timber construction products, and encouraged the use of alternative materials (Liu et al., 2005). By 1998, the “National Forest Protection Program” controlled and reduced the proportion of wood materials in the residential building sector (Fan and Chen, 2004; Lv, 2010). For these reasons, before the 1960s, the main construction materials of civil buildings in China were timber and brick (Zhou, 2012), but currently, the major construction materials are brick, concrete, and steel (Liu et al., 2005).

The main differences between Chinese style traditional wooden structures and modern wooden structures (MWS) are: MWS are generally constructed with industrialized engineered wood products, assembled with metal connectors through mechanical calculations, and have certain guidelines and standards for the construction processes and acceptance checks; while traditional wooden structures are usually constructed with raw materials which have been processed by carpenters using mortise-and-tenon connections, and the quality of construction basically depends on the carpenters' skill and experience. With modern construction techniques, many drawbacks of the traditional wooden structures, such as damp, rot, and insect and fire issues, have been eased.

Although the MWS industry started rather late in China, the market has shown a trend of rapid growth after 2000 (Zhou, 2012). From 2003 to 2012, 15 national MWS building codes, including design,

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construction, acceptance criteria, fire protection and anti-corrosion norms and standards, and technical instruments have been promulgated in China. From CSUS Report (2014), the gross floor area of MWS in China was about 15 million m^2. While three years ago, by 2011, the completed new MWS construction area was only 3.08 million m^2, and the market size was valued at about 1.33 billion USD (the annual average exchange rate of 2011 was 1 USD = 6.46 CNY). However, despite the rapid development, the MWS industry is still situated in a fast growing market with a low market share. For example, a National Bureau of Statistics of China (NBSC) report in 2015 stated that, during 2014, the completed new construction area in China was 1.08 billion m^2, meaning that MWS accounted for only about 0.35% of it.

Japan also has a long history of timber construction. Wooden structures also played a major part in the history of Japanese architecture (Sasaki et al., 2007). The world's oldest wooden building (the Horyuji temple, built in the 7–8th century) and one of the largest wooden-frame buildings (the Todaiji temple) both extant in Japan. The timber demands in the construction sector had a far-reaching impact on the forest resource management from the ancient times in Japan (Takahashi et al., 2017). The structures of such traditional wooden buildings used post-and-beam structures with mortise-and-tenon connection, which was introduced from China and the Korean Peninsula (Yamato, 2006). From tiny tearooms to large palaces and castles, all kinds of buildings have been built using wood. About 90% of Japanese historical buildings that were designated as “Important Cultural Buildings” are wooden buildings (Yagi, 2000). However, since the 1950s, Japanese government as well introduced policies to reduce timber construction materials to avoid fire issues and domestic forest degradation. Specifically, timber use for public buildings, such as city halls and schools, has been strictly limited (Yamada, 2012).

Although the timber use for public buildings and large scale buildings has been limited, its use for residential buildings is still popular; indeed, 92.2% of single-family residences were wooden structures (Statistics Japan Report, 2014). There are three major construction methods for MWS residences in Japan: the North American platform-frame system (referred to as “2 × 4” in Japan), the prefabrication method, and the “Japanese post and beam” method. The Japanese post and beam method is the most widespread method, and accounts for > 75% of all new-built wooden residences in Japan each year (MAFF, 2016). The Japanese post and beam method is a combination of traditional Japanese style wooden structure and the modern methods (Gaston et al., 2006). However, the Japanese post and beam method has experienced three evolutionary stages from the past to the current method. Metal connectors for wooden structures were firstly introduced to Japan around 1900. After the second world war, in 1950s, a law of “Building Standards Act” has been promoted by the Government Housing Loan Corporation (GHLC). This “Building Standards Act” established wooden construction standards in Japan, which enhanced the metal connectors utilization. Furthermore, from 1980s, and especially after the great Hanshin earthquake (1995), by promotions from western housing companies, and because of increased security awareness of consumers, the use of kiln-dried and pre-cut timber construction materials has been popularized. The wooden structures which have been constructed during the revolution stages, and have not yet been fully applied above MWS criteria, were referred to as “early modern wooden structures” in Japan (Endoh, 2000; Kikuma and Masuda, 2004; Koshihara, 2013).

Given Japan's aging and declining population, the market for residential buildings showed a downward trend at present and is expected to decline further in the future (Nomura Research Institute, 2016). The Japanese MWS residential market has reached a mature stage. According to the statistic s of MLIT (2016), during the year 2000, there were 555,814 new-built wooden houses, which accounted for 45.2% of all new-built residences. However, while the new-built wooden house percentage increased to 55.5% in 2015, the number decreased to 504,318 houses, because the total number of new-built houses in Japan declined. From 2000 to 2015, the yearly number of new-built wooden houses in Japan has fluctuated around 500,000 houses.

With the advent of technology, concerns relating to environmental issues increased, therefore the impression of wooden constructions have been changed from being “a low-value and low-tech wood product” to “a high-tech and high value added product” because of the recognition of its “green” characteristics (Wang et al., 2014). Many researchers have explored MWS at a technical level with regard to their environmental performances (Robichaud et al., 2009; Tykkä et al., 2010; Sathre and Gustavsson, 2009; Knowles et al., 2011; Noel, 2012) and health-related characteristics (Koch, 1992; Schlamadinger and Marland, 1996; Buchanan and Levine, 1999; Upton et al., 2008). However, very limited researches of MWS from an economic perspective have been conducted. As Petersen and Solberg (2005) and Gustavsson et al. (2006) pointed out, the micro-economic level studies, such as studies examining consumer behavior related to wooden construction and substitution researches, are still far from being enough.

The aim of our study was to partly fill this research gap. First, we identified important determinants of consumers' willingness to pay (WTP) for MWS. MWS possesses better environmental performances (Eastin, 2008) and better well-being advantages (e.g. higher indoor environmental quality (IEQ)) compared with conventional concrete and steel constructions; additionally, compared with traditional and early modern wooden structures, MWS also feature advanced architectural performances (e.g. higher stability and longer durability). In the purchases, the WTP for MWS is supposed to be mainly based on the consumers' comprehensive reflections and recognition of the architectural, well-beings and environmental performances of MWS. In previous studies, to identify consumer WTP for value added forest products, analyses are mainly focused on the consumer perceptions on the environmental performances of forest products, e.g. studies on certified wood products (Ozanne and Vlosky, 1997; Vlosky et al., 1999; Aguilar and Vlosky, 2007; Cai and Aguilar, 2013; Shoji et al., 2014; Yamamoto et al., 2014). However, in construction market, when consumers consider wood as an alternative construction material, its architectural performances are probably the primary consideration for consumers, such as fire resistance, acoustic insulation, resistance, serviceability, and durability; and then next, well-being and environmental performances would be involved (Gold & Rubik, 2009). Thus, our study explored consumers' integrated attitude towards MWS which is reflected in their WTP for different types of MWS buildings.

Second, wood as a substitute construction material has been analyzed only in durable goods (residences) in previous studies (Gronroos and Bowyer, 1999; Gold & Rubik, 2009; Thomas et al., 2013). Durable goods are generally considered as products which can be used continuously for three or more years (Sullivan and Sheffrin, 2003). However, to different consumers (not construction owners), according to the length of their consumption, buildings constructed with wooden materials could also be considered as non-durable goods (immediately consumed in one use or use for less than three years) or services, such as MWS hotels or other public buildings. Compared with non-durable goods, durable goods are typically characterized by high unit cost, long life span and low frequently of purchase; indeed, the purchase of durable goods involves a different decision-making process, such as more information seeking and longer considerations, to reduce potential risks (Dasar et al., 2013). Since no reported study has compared wooden construction in these two forms, this study first analyzed MWS as durable and non-durable patterns at the consumer level.

Additionally, Japan and China possess similar traditions and architectural cultures to some extent, but different political, social, and market environments. As mentioned above, the MWS market in Japan is relatively developed, while that in China is still at an introductory stage. This study also explored differences related to consumer perceptions of MWS under different market environments by assessing differences between consumer WTP in China and Japan.