

KARELIA UNIVERSITY OF APPLIED SCIENCES  
Degree Programme in Forestry

Panu Runko

PERCEPTIONS OF FINNISH WOOD PRODUCTS IN SHAANXI,  
CHINA

Thesis  
May 2020



**THESIS**  
**April 2020**  
**Degree Programme in Forestry**

Tikkarinne 9  
 80200 JOENSUU  
 FINLAND  
 + 358 13 260 600

Author (s)  
 Panu Runko

Title  
 Perceptions of Finnish Wood Products in Shaanxi, China

Commissioned by  
 EduSilva ry.

**Abstract**

The need for environmentally friendly building solutions offers a chance for wood-based construction to become more popular. China is a country that has started to put more focus on the development of green building as well as improving the overall state of their environment. It is also a huge market area and one of the top constructors of new apartment buildings, making it a potentially strong candidate for importing Finnish wood products. This thesis will focus on the province of Shaanxi, where Finland already has established a direct railway connection.

The data for this thesis was sourced via a questionnaire survey distributed in the province of Shaanxi to three different respondent groups. The questionnaire asked the respondents to first review different wood samples of pine, birch and ash, secondly to give their opinions on wooden construction, and lastly how it could be promoted. The results were analyzed both qualitatively and quantitatively, and they formed the basis for the results of this thesis.

According to the results obtained, the most preferred samples were pine wood, and overall darker wood samples would be the most desired ones. The biggest advantages of wooden construction according to the respondents were their pleasant appearance and the image of healthy and environmentally friendly building. Biggest disadvantages were durability related qualities, such as respondents worry about wooden buildings not being safe against fire or corrosion. To advance wooden construction in China, it was thought that state supported policies promoting the use of wood in building are needed.

Language	Pages	54
English	Appendices	7
	Pages of appendices	36

Keywords  
 Perceptions, China, wood products, survey

## Table of contents

1	Introduction .....	1
2	China .....	3
2.1	Urbanization and Construction in China .....	3
2.2	New Environmental Policies in China .....	4
2.3	The Belt and Road Initiative.....	5
3	Forest Industry Trade Between Finland and China.....	6
3.1	Finnish Forest Industry Exports to China .....	6
3.2	China's Timber Imports.....	7
3.3	Finland's Opportunities in the Chinese Wood Market .....	7
4	The state of Wooden Construction in China .....	8
4.1	History of Using Wood in Construction and Decoration in China .....	8
4.2	The Current State of Wooden Construction in China .....	10
5	The Advantages of Wooden Construction .....	12
5.1	Environmental Aspects .....	12
5.2	Durability Against Fire.....	13
5.3	Safety Against Earthquakes.....	14
5.4	Benefits for the Human Mind and Body .....	15
6	The Goal of the Thesis.....	17
7	Materials and Methods.....	18
7.1	Materials .....	18
7.2	Research Methods Used in This Thesis .....	20
8	Results from Likert Type Questions .....	22
8.1	Healthiness, Eco- and Climate-Friendliness of the Samples .....	22
8.2	Aesthetic Elements and Color Preferences .....	25
8.3	Anticipation of Costs Related to Use in Residential Housing .....	28
8.4	Modernity.....	30
8.5	Durability.....	32
8.6	Used as a Material in Own House, or in a Hotel .....	34
9	Results from the Open-Ended Questions .....	37
9.1	Qualities Associated with Each Wood Sample .....	37
9.2	Improvement Suggestions .....	39
9.3	Wooden Construction and Décor.....	40
9.4	Advantages and Disadvantages of Wooden Construction .....	41
10	Constraints and Problems Encountered During the Study .....	43
11	Discussion and Conclusions .....	45
11.1	The General Perceptions .....	45
11.2	Potential Effects on Wood Products Export o China .....	48
11.3	Ideas for Future Research .....	49
	References.....	51

## Appendices

Appendix 1 Results for the sample A2 – ‘Pine natural ceiling/wall panel lacquer’

Appendix 2 Results for the sample A4 – ‘Pine floor trim transparent white lacquer’

Appendix 3 Results for the sample A5 – ‘Pine wall panel, wall décor, round trim’

Appendix 4 Results for the sample B2 – ‘Ash floor’

Appendix 5 Results for the sample B4 – ‘Birch natural, sanded and wax oiled’

Appendix 6 Translated questionnaire for the eco-hotel customers and ordinary people groups

Appendix 7 Translated questionnaire for the experts group

# 1 Introduction

The rising global trend in wooden construction is driven by the looming dangers of environmental catastrophes caused by pollution, as well as people's pursuit of more comfortable living conditions. Because of this, the world has turned its attention back towards to make buildings out of wood, as a material for near carbon neutral alternative to replace conventional building methods. (The Guardian 2018) Currently the biggest problem with using concrete and steel as a construction material is mainly the amount of pollution it creates. In 2015 the cement industry generated approximately 2.8 billion tons of CO<sub>2</sub>, which would make around 8 % of the total global carbon dioxide emissions. This means that the emissions of the global cement industry produced a greater share of carbon dioxide than that of an any country in the world outside of the United States of America or China. (Olivier & Janssens-Maenhout & Muntean & Peters 2016, 64-65.)

If the timber needed for construction was harvested using ethical and sustainable means, it would provide an excellent carbon sink, making it possible to aim for zero-carbon building. Using timber as a construction material would keep the carbon out of the atmosphere for the time the building is in use. As a growing tree can absorb approximately 750 kilograms of carbon dioxide, and at the same time release 700 kilograms of oxygen to the atmosphere via photosynthesis. (Puuinfo 2020)

One of the world's largest building manufacturers in the world is The People's Republic of China (Glaeser & Huang & Ma & Scheifer 2016), and this thesis aims at to explore ways how Finnish forest companies and institutes could work to promote, advance and provide materials for wooden construction in China. This work is based on a collaborative survey conducted by Finnish non-profit organization EduSilva ry and Northwest A&F University of Xianyang (NWAUFU) who aim to find out what kind of wooden material would be the most suitable to be imported from Finland to the Northwest Chinese wood market. The data for this thesis has been collected via questionnaire survey, where Chinese respondents were asked to rate five wood trim or parquet samples and to give

their opinions about wood used as a construction or a decorative material. This work could be seen as a kind of a follow-up to the study made by Qu & Pelkonen & Tahvanainen & Arevalo & Gritten (2012) that assessed the development of wood framed houses in China. The result of that study was that Chinese wood framed housing sector was at the time very potential but underdeveloped and lacking support. Whereas that study focused on experts' opinions on how wooden construction could reach its potential in China, this is a group study focused on surveying the perceptions regarding specific wood samples and using wood as construction material among both experts and other groups, aiming specifically to the province of Shaanxi in Northwest of China.

As background information this thesis will also explore the political and commercial relations between Finland and the Peoples Republic of China, as well as background in the history and cultural significance of wood in China.

After this it is possible to mirror these aspects to the modern-day climate, and to find some reasons why China has moved on to use concrete and steel-based buildings instead of wood, whether there are any changes in wood use in sight, what aspects of wood could be promoted for wooden construction to become more popular and how it could be done, what kind of wood products would be the most potential ones on the wood market of Shaanxi in Northwest China and how companies in Finland could use this information for expanding business relations with China in wood sector. The thesis also goes through some aspects of how and why Finnish companies could advance to this market so that it would be beneficial to both parties. Due to the size of China, and both cultural and historical differences between provinces, this thesis will focus assessing the Northwest Chinese market with data collection on this study being conducted in the Shaanxi province. Other aspects such as social policies and their effects on green building will be viewed in the context of whole China if, and when possible.

## **2 China**

### **2.1 Urbanization and Construction in China**

The People's Republic of China is the most populous country in the world with population of over 1.4 billion. Simultaneously, it also has the third largest area of all nations with 9.6 million square kilometers. (The World Bank 2020.) After China reformed its economic policies in 1978, it has experienced rapid economic growth and lifted a huge amount of its population out of poverty. The urbanization of the country has happened in relatively short time, as in 1950 only 13 % of Chinese citizens lived in cities. This percentage grew to 45 % in 2010 and is projected to hit 60 % by 2030. This type of rapid advancing in quality of life is also shown in the growth and development of massive cities like Beijing, Shanghai and Guangzhou as well as the likes of Shenzhen that grew from having only few thousand citizens in the 1950's into having population of over 10 million in 2010. (Seto 2013.)

The rapid and still ongoing urbanization and growth of cities has caused a need in constructing new buildings. During the time span of 2003 to 2014, the yearly average amount of new apartments built in China was 5.5 million. In 2014 the construction industry employed 29 million people which amounted to 16 % of the urban work force. (Glaeser & al 2016.)

This effect can be seen in China's enormous concrete consumption. China is the world's largest producer of concrete, its production of concrete climbed between 2005 and 2015, and the most recent peak in annual production of 2.45 billion tons was hit in 2014. In 2018 the amount of cement sold was 2.17 billion tons. The eventual risk of overproducing cement was met in 2012 when National Bureau of Statistics of China warned that the cement production overwhelmed its need. The Chinese government started to issue new guidelines in cement production in 2013, and in 2017 the production was slowed down, with over 500 cement grinding plants planning to be closed by the end of 2020. Behind these guidelines were both financial and environmental worries regarding the production of cement. (Edwards & Perilli 2019.)

## 2.2 New Environmental Policies in China

Looking at the amount of cement-based construction going on in China, it would be an obvious target for promoting wooden construction. Considering this, in the first half of 2019, the government of China introduced numerous new policies regarding green building and zero-waste cities among others. For example, 'The Green building evaluation standard' put into effect in August of 2019 adds wood frame construction to accompany concrete and steel as a future building solution. This aims to promote and encourage the usage of renewable construction materials (Wang 2019). Another one is the new national standard for nearly zero energy buildings that was enforced in September of 2019. The standard is designed to define concepts and establish technical systems on how China will plan to reach the goal of near zero energy construction. It is based on numerous characteristics of China, from natural such as its climate, to more social ones like building types and energy usage. The standard will regulate ultra-low and near zero energy buildings markets as well as work environments and promote emission reduction. One of these goals will see the increase of green buildings in new construction projects by 50 % in 2020. (Xu 2019.)

Other environmental policies set by China include the "2018-2020 Three-year action plan for winning the blue-sky war" that is taking over from previous five-year plan designed for 2013-2017. The previous policy was implemented to improve the notorious air quality of larger cities like Beijing. As an example, in Beijing this led to banning the burning of coal for heat and shutting down coal-fired power stations. This managed to improve the air quality in Beijing by lowering PM2.5 pollution levels by 35 %. The current policy to improve air quality in Chinese cities is meant for the other 231 cities out of 338 that are prefectural level or higher to follow the example of previous cities like Beijing that dropped their PM2.5 levels to the target of 60 micrograms per cubic meter or lower. The three-year action plan is created to emissions of major pollutants in coordination with reducing greenhouse gases, which in China would mean targeting major users of fossil fuels, such as coal. (Hao 2018.)



These new social policies and reforms will be enforced in future by the China's corporate social credit system which will be launched in 2020. It will mirror the social credit system that is in use for the nations citizens, meaning that negligence of environmental policies will lead to penalties, such as removed tax breaks, more frequent inspections and limitations for obtaining certain licenses. Among newly implemented social policies, China is launching new financial projects, for example the National Green Development Fund, abbreviated as NGDF, which will have a green focus on national investments. This will be the first investment fund in China to focus on environmental aspects, although some other projects such as the Belt and Road Initiative have had elements that have previously taken these into consideration. (Davies & Liu 2020.)

### **2.3 The Belt and Road Initiative**

One of the bigger global projects China is currently undertaking is The Belt and Road Initiative, often abbreviated as "BRI" and nicknamed "The New Silk Road", which is amongst other reasons a major factor why China is becoming even more notable in the global market. It is a program proposed by China to connect Africa and Europe to Asia, mainly China, via land and sea routes to boost economic growth and create trade. (Belt and Road Forum 2019.)

This project is also visible in Finland in numerous forms. The amount of money invested into Finland by China in recent years has been seen in forms of new pulp mill projects, the purchase of a Finnish mobile game company Supercell by Chinese tech conglomerate Tencent as well as new airline connections opening between China and Finland. (Chen 2019) After numerous years of planning there was also an opening of a railway connection between Kouvola and Xi'an. The direct railway connection of 8 000 kilometers established in 2017 focuses on cargo and has already been used for transporting goods such as timber, machine parts among others. But regardless of this the railway is currently underused, and for example in the year 2019 there were only three trains from Kouvola to Xi'an, and none from Xi'an to Kouvola. Thus, boosting the export of wood or wooden construction material to China would create new opportunities to Finnish forestry

companies and cooperation between the two countries, but also it could be the perfect way of rejuvenating the railway connection. (Skön 2019.)

### **3 Forest Industry Trade Between Finland and China**

#### **3.1 Finnish Forest Industry Exports to China**

The forest industry is both a significant employer and a major source of income in Finland. In 2014 the exports from Finnish forest industry total amounted for 20 % of all of Finland's exports. (Finnish Forest Industries 2015) Forests in Finland grow nearly 110 million cubic meters of stem wood a year, of which around 70-80 million cubic meters, or 65-75 %, have been utilized annually in the recent years. It is estimated that this amount could be grown by 10-15 million cubic meters, while still keeping the forest industry environmentally stable. (Karjalainen 2020) In the year 2018 Finland exported 2.1 million cubic meters of raw wood, and the total value of forestry exports was estimated to be around 13.2 billion euros (Kaihlänen 2019a).

In recent years China has been a major importer of Finnish wood products, and it occasionally has been the number one country in receiving Finnish wood exports. The peak numbers were 1.7 million cubic meters being imported to China in 2017, but after this record year the number has been declined and is currently around 1 million cubic meters of wood per year. (Kaihlänen 2019b). Adding the vast forest reserves of Finland to the logistically important railroad between the Finnish city of Kouvola and the Chinese city of Xi'an creates an excellent opportunity for Finnish companies to expand their businesses to east. Traditionally, a major part of Finnish wood exports to China have been wood pulp and paper. But due to the downward trend in pulp prices (Brännare 2019), and ability to harvest high quality wood in Finland, companies could consider exporting wooden building materials and to promote wood-based construction with Finnish expertise in China.

### **3.2 China's Timber Imports**

When looking at the big picture of Chinese wood importing, in 2017 the most active wood exporting country to China was clearly Russia, who exported over 30 % of all of China's import wood. The United States, New Zealand and Canada formed the rest of the top-4 with Russia (Research and markets 2019). The main reason behind these countries being the top importers of wood is their geographical location combined with forest reserves. Russia can easily bring timber to the northeastern inland port of Harbin, but also use land route to the same city, or into another major wood importing city of Manzhouli in Inner Mongolia. The U.S. and Canada in turn can use maritime routes for importing timber to China's larger eastern cities, such as Shenzhen and Shanghai by freight ships. At the present day due to the so-called "trade-war" between the United States and China, China is looking to increase its wooden imports elsewhere. The providers that already have increased their exports to China include Canada, Russia and the EU. (Wood Resources International LLC 2019.)

### **3.3 Finland's Opportunities in the Chinese Wood Market**

Following the footsteps of other major wood importers, it can be possible for Finland to get a foothold in the wood market of Shaanxi using the railroad between Kouvola and Xi'an as the means of transportation for timber exports. The high-quality timber products of Finland could be very valuable if used in wooden construction. As currently the most of China's busiest wood importing hubs are located in the east coast, the areas of Northwestern Chinese wood market could be open for the Finnish wood imports. This could be very beneficial to forest companies in Finland looking for to expand their market, and at the same time providing renewable construction and decoration material to a market of that magnitude would be beneficial to the environment and sustainable living as well.

Other than exporting timber to China, Finland can also strive to exporting the knowhow in forestry and, more importantly, in sustainable forest cultivation to China. According to professor Paavo Pelkonen who formerly taught in the University of Eastern Finland, Finland should follow the way of universities in

Great-Britain and Canada by offering paid education in forestry expertise to foreign students, a method widely ignored in the Finnish education system. Particularly Finnish knowledge in sustainable forest management and reforestation are topics that have already caught the eye of some Chinese universities. For example, in the summer of 2019 Karelia University of Applied Sciences held a 3-month study period for Chinese bachelor's students of forestry from the Northwest Agriculture and Forestry University located in the Shaanxi province. This study period included one week of learning about end-use of timber, including wooden construction and architecture. According to professor Pelkonen, educating Chinese students using this method improves their knowledge of Finland and about Finnish forestry. Once the students graduate and start to work either for state, private firms or start up their own companies, they will have a good knowledge of Finnish forestry and its forest related exports. (Laukkanen 2019.)

## **4 The state of Wooden Construction in China**

### **4.1 History of Using Wood in Construction and Decoration in China**

The history of China is very vast, and due to wood being used throughout from the early settlements to the modern day, it is very difficult to go through everything. Therefore, some of the more important ones have been selected here, to hopefully give a better understanding of the historical aspects of using wood in Chinese construction and decoration.

The earliest discoveries of wooden framed houses in China date back to almost 7000 years ago, as primitive societies started to settle around the Yellow River and the Yangtze River. Most of these structures were made from interwoven branches covered with mud coating to form primitive walls and roofs. Moving towards 2000 BC proper wooden framing as well as enclosed courtyard buildings started to emerge as early as 21<sup>st</sup> century BC. From 1000 BC onwards

construction of log cabin type houses began to emerge, which were constructed similarly to the old Finnish log cabins by stacking carved logs on top of each other. After transforming from slavery-based society to feudalism, the development of agriculture and craftsmanship started to rise, and improved the quality of wooden structures. It is estimated that the Han Dynasty (200 BC – 200 AD) was the period when the through-type wooden framing in houses became very popular in rural housing, a method which is currently seen as a part of classic Chinese architecture. This frame is made by connecting both the structural columns of the walls and roof of the house with vertical wooden beams. This building method made the simple installation of sturdy wooden walls possible in residential housing. (Que & Li & Zhang & Yuan & Pan 2017.)

Later during the Song dynasty (960 – 1279) when printing and bookmaking were discovered, a set of rules regarding construction were set, defining the size of the wooden building materials. This popularized the use of beam-lifted framing, that shares the gravitational force downwards throughout the wooden frame. The buildings inside the forbidden city are good examples of this, although the types of beam-lifted framing houses varied between the social ranks. Towards the end of Feudalism in China during the Qing dynasty (1644 – 1911), the procedure of making buildings simplified with the advances of beam-column framing, and at the same time the effect of multiculturalism and ethnic diversities shaped the field of building types in residential housing to become more varied than before. (Que & al 2017.)

Wooden furniture has been made throughout the history of China, but the biggest and most notable advances in making furniture developed greatly during the Ming dynasty (1368 – 1644), and the production of handmade furniture from woods such as padauk and rosewood became more popular especially with the richer class. Both of these woods are dark and reddish hardwoods that were popular due to their hardness and corrosion-resistance. Combined with their beautiful color and durability they were well suitable for furniture making. People who could not afford the more expensive materials, used woods like pine and elm. (China

Today 2018) Similarly these days the latter ones are more commonly used in Chinese furniture instead of material such as red wood, due to its harvesting being highly unethical and linked to illegal logging and trade (Treasor 2018). The usage of wood as decorative material in China was historically mostly furniture, but other decorative elements such as bowls and sculptures were made from wood and then covered with lacquer finishing, producing colored and well preserving products named “lacquerware”. The earliest discoveries of lacquerware are from earlier than 2000 BC and have continued throughout the history of China. Some of the examples of lacquerware made from wood are animal sculptures, wooden screens or wall panels, bowls, coffins and the most famous one is a carved lacquerware table from Ming Dynasty that is currently being held in the Victoria and Albert Museum in London, England. (Cartwright 2017.)

#### **4.2 The Current State of Wooden Construction in China**

Coming into the 20<sup>th</sup> century, the usage of wood as a construction material in China started to become rarer due to rapid industrialization and shortage of timber (Qu & al 2012). But recently as the Chinese economy has started to advance, a demand for quality residential buildings has started to rise as well. While considering the current environmental problems in the world, eco-friendly and sustainable housing is becoming more attractive in China as well. Up until the recent years the problems of wooden construction in China were the lack of knowledge regarding the subject and strict regulations on building and harvesting natural resources that made it difficult to fulfill the housing needs with buildings made of wood. This led to steel and concrete becoming the dominant materials used in building industry, but the requirements for buildings are becoming such that these materials cannot meet the demands in comfortable housing. (Chen 2013.) Due to this the Chinese government has started to encourage the usage of wood as a construction material, and to compensate the usage of natural resources. In 2019 China has revised its policies regarding harvesting wood to improve its sustainability. This change can be seen in the creation of new policies regarding lowering the construction tax, promotion of resource conservation and

recycling as well as new forest law which concerns harvesting quotas and logging permits among other factors. (Wang 2019.)

The current need for wooden construction in China is caused by three major reasons. Environmental friendliness and the need for more comfortable and higher quality housing. Wood has numerous qualities as a building material that trump those of concretes. For example, wood as construction is much better in terms of thermal insulation. It is 15 times more effective than concrete, and 400 times better compared to steel. When the performance of wood as building material is compared to the requirements of energy efficiency in China, they meet all the relevant requirements. (European wood in China 2020.) This means that when using wood as a construction material there is no need to use additional funds to improve these factors.

A major problem of China's rapid development is the stress it causes to the environment. As the energy demand of China is currently met by using fossil fuels, which emit a lot of CO<sub>2</sub> to the atmosphere. Currently 40 % of energy consumption is due to energy demand of buildings, of which 80 % are built using materials that require fossil fuel (European wood in China 2020). When considering the positive effects in lessening the need for energy and fossil fuel use, as well as wood being relatively inexpensive building material but managing to be very versatile in design, it seems to be an optimal building material for Chinese building market.

## **5 The Advantages of Wooden Construction**

### **5.1 Environmental Aspects**

One of the main reasons in the rise of wooden construction and usage of timber is its low stress on the environment. If the timber used in construction is harvested from forests that have been grown using sustainable forestry methods, the sourcing of materials requires less fossil fuel and limited resources compared to those used in steel or concrete that have notoriously high water and energy consumption in their production process. (Leuschel 2019.) Another advantage of building made from timber is their ability to work as a carbon sink, meaning that the wooden materials of said building can store CO<sub>2</sub> for most of their lifespan. Given that the estimate for an apartment building made out of wood could last around 100 years of use (UPM 2020), and that every cubic meter of wood could store approximately 750 kilograms of CO<sub>2</sub> (Karjalainen 2020), means that an apartment building made completely out of wood can keep a significant amount of carbon dioxide from being released into the atmosphere.

On the contrary, in concrete and steel, where the production of 1 000 kilograms of cement emits almost 900 kilograms of carbon dioxide (Mahasenan & Smith & Humphreys 2003), and for every ton of steel produced, half a ton of CO<sub>2</sub> is released (Elbein 2020). Also, during the construction phase more energy is required in erecting the building made of concrete and steel due to the weight of the materials than it is needed with wood, due to it being lighter. Because of the carbon stored inside the wood, and the fact that the production of wooden construction materials can be made by emitting only a small amount of carbon dioxide, it is possible to create lumber designed to be used as a building material that has a negative carbon footprint (Kuittinen & Werner 2020). Thus, the transition from concrete and steel-based construction to construction by wooden materials would be vastly beneficial for the environment.



Another environmental aspect that is prominent in wooden buildings is them being very energy efficient. In 2011 a study assigned by Sitra and completed by Bionova consulting compared a wooden framed 5-storied apartment building to an equivalent apartment building made with concrete elements. It was found that the wooden framed apartment building had 5-11 % smaller lifecycle emissions, and if only the construction phase would be taken into account, the difference would be 29 % lower emissions for the wooden framed building. Though it's worth pointing out that the wooden framed building was not completely made from wood, but instead had concrete casted floors and an elevator shaft. (Pasanen & Korteniemi & Sipari 2011.)

## **5.2 Durability Against Fire**

Fire safety is often assumed to be the main weakness of a wooden structured building. However, because the flammability behavior of wood is well known, it is possible to make very accurate calculations on how durable the structures are against fire. For wood to catch fire it requires both oxygen and heat, if the area around it has either higher heat or stronger heat radiation the faster the wood will ignite. Using an example of a fire in a closed space, such as an apartment fire, the temperature first climbs slowly to around 400 Celsius. During this first stage, the wood begins to char. While charring the wood releases organic compounds poor in oxygen that cause a redox reaction. This essentially means that it uses the limited amount of oxygen in said closed space, eventually leading to the fire dying as long as it does not have access to new reserves. The charred layer formed in the burning process can slow down the heat transfer inside the outer layers of the wood, thus providing protection in a load-bearing structure, preventing or slowing the collapse of the building. These load-bearing wooden structures do not need any excess fire protection, but if they have any connected parts or structures made out of steel, these must be protected as regulated due to them not having the same qualities in fire protection as thick solid wood pillars. Solid wood is a great option to be used as a load-bearing structure due to it having a fire resistance of 30 to 90 minutes, meaning it can withstand fire penetration for that long. (Siikanen 2008: 164-166.)

Fire penetration is measured by calculating the speed and depth of charring. In an average building fire, the temperatures will be above 700 Celsius. After 30 minutes of withstanding a fire that has reached 750 Celsius, a solid wood beam has still retained 75 % of its strength and managed to hold its structural ability thanks to the protective layer formed in the charring process. Whereas at this point a steel beam has retained only 10 % of its strength and is not able to hold any structure, meaning it has most likely collapsed. (NZ Wood 2020.) When considering these qualities, it can be taken so far as to claim that wooden structures are safer against fire than steel- or prestressed concrete structures. However, it is important to remember that for instance the furnishing of the house, poses the greatest threat during the fire instead of its structures (NZ Wood 2020).

### **5.3 Safety Against Earthquakes**

Another one of wood's special characteristics is its capability to handle earthquakes better than other conventional building materials. Because the force of an earthquake is proportional to the weight of the building, wood has an advantage to other building materials due to it being comparatively light weight.

Another advantage is that wooden buildings have redundant load paths, for example how wooden framing is connected, along with walls and even sometimes wooden floors that have usually other structural panels e.g. plywood or boarding that help to distribute the stress caused by the earthquake to be distributed around numerous load paths. These structural add-ons are also connected via multiple nailed connections allowing slightly ductile, flexible behavior of the structure. While being able to handle some movement and being flexible, wooden buildings are also strong and stiff for largely the same reasons why they have numerous load paths. These multiple connections and fastenings done by framing, nails and other methods help wooden buildings to deal with lateral distortion during earthquakes.

Great examples of mass timber products designed for construction of the future are cross-laminated timber, commonly abbreviated as CLT, as well as nail-

laminated timber, NLT. These two materials are getting a lot of attention in the field of research and were deemed to be effective as well as cost-competitive in study done in coastal British Columbia in 2016. (American Wood Council 2019) Especially the first one of these two is being touted to be the future top candidate for construction material in taller timber buildings, although it has already been used in taller wooden structures, there is still need for research for its seismic properties. And as an example, in Canada CLT-buildings are prohibited to exceed 30 meters, and 20 meters in high seismic zones respectively (Tannert & Follesa & Fragiacommo & Gonzalez & Isoda & Moroder & Xiong & van de Lindt 2018).

In 2019, a 14 storied steel rod-braced wooden apartment building close to 50 meters tall called “Light House Joensuu” was built in Joensuu, Finland. Like the tall wooden buildings in Canada it also uses CLT as a bottom, as well as in structural elements, but the difference is it being almost twice the height of its Canadian counterparts. (Woodarchitecture.fi 2019.) This building should be an important research subject when considering the durability and maintenance, as well as for the structural elements and properties such as soundproofing, the ability to handle subsidence and moisture (Karelia University of Applied Sciences 2020) for tall wooden apartment buildings going for the future.

#### **5.4 Benefits for the Human Mind and Body**

The effects of wooden surfaces to the human mind seem to be highly similar to those of nature. They also appear to be able to provide more soothing and invigorating atmosphere than synthetic or artificial-looking surface materials. Studies performed in countries such as Japan, Norway, Austria and Canada have shown that surroundings with wooden surfaces can result in reduced pulse, heartrate and calm people down. In these studies, it was observed that wood was considered as a softer material physically as well psychologically than others, and that touching the surface gave a feeling of safety and being close to home or nature. (Puuinfo 2014.) As an average of 88 % life is spent indoors (Fell 2010), the atmosphere and other elements of comfort should be highly prioritized in our

everyday life. No matter whether it is home, school, work, hospital or another place where one might have to spend a significant amount of time in one visit, the possibility to experience less stress and to both improve the general mood and quality of life. These aspects on the other hand can improve persons vigor and productivity, which is why the productivity while working in spaces where wood or other natural elements are visible, can improve ones' productivity. (Knox & Parry-Husbands 2018.)

Due to wood's pacifying effects as a decorative element, it is being viewed as the optimal material for paneling spaces that have people spending a lot of time in them, e.g. hospitals, hospices, offices and of course homes. Nordic countries like Denmark, Norway and Finland for example have started using it as a decorative element in healthcare facilities to create a soothing atmosphere for patients, but it has been discovered to help maintain a healthy air-humidity for patients suffering from asthma or allergies. (Laukkanen 2014) In Kainuu, Finland a new hospital wing is being built for the year 2021 that incorporates some of these wooden elements as decorative paneling and in wards. (Roivainen 2015) And in Akershus, Norway, there already exists a ward that is decorated with wood paneled walls and windows, aiming to provide as much daylight and as natural feeling surroundings as possible, due to their effects on patients spirits, which positively supports the recuperation process of patients (Laukkanen 2014).

Other than hospitals and homes, wooden paneling can be used to reduce stress at workplaces or schools. As it has been researched that natural materials such as wood used in decorations and furniture can lower stress in test like situations compared to those that had non-wood finishes (Fell 2010), It could be imagined that wood would be preferred material for environments where occasional stress is being experienced. An example of an office type building constructed using wood is the Metla Building on the campus of University of Eastern Finland in Joensuu. It was built with wood framing, and both the outer façade as well as some of the inner surfaces are covered with wood paneling. (Luonnonvarakeskus 2020.) And as wooden based construction of buildings such as schools is getting

more popular in Finland, the Finnish University of Oulu and the city of Kuhmo have started a research project that aims to assess the effects of wooden buildings on stress experienced by elementary school students as well as its effect on their health. The research will compare two schools of which one is concrete-structured building and the other one is wooden-structured, both of around same age. The report is aimed to be published in 2021. (University of Oulu 2020.) Studies like these considering school and workplace comfort are going to be more and more topical, and their results could also help to promote wooden construction in fields other than housing.

Wooden construction can also be used when constructing recreational buildings such as stadiums for example. In Joensuu, Finland wood has been a prominent element when constructing two sports complexes. Joensuu Areena, a wood framed multipurpose hall that was the largest wooden building after its completion in 2004. And the second one being the Kerubi Stadium, which was opened in 2018. The open-air stadium was primarily built to function as a stadium for Finnish baseball but has held concerts and other public attractions. The main wooden elements used in its construction were laminated veneer lumber, sawn timber and façade lathing among others. (Wood Joensuu 2020.)

## **6 The Goal of the Thesis**

The thesis is trying to explore ways of how Finnish forest companies and institutes could work to advance, promote and provide materials for wooden construction in China. This is being done by examining the perceptions of Chinese citizens on five different Finnish wood samples, such as parquet and wood trim, and other perceptions regarding wooden construction and wood products.

After analyzing the survey results there will be also an estimate made on what type of material is best suited to be imported from Finland to Shaanxi and why.

This will be investigated both from the area of five samples provided with the questionnaire, while also considering all the preferred qualities and making hypotheses of which other types of wood would be valued in the market area of Shaanxi. It will also go through some points of how Finland and especially Finnish small and medium-sized companies could advance to the Chinese wood market in search of a foothold. The potentially most efficient method of importing wood products from Finland to China would be using the railway route between the Finnish city of Kouvola and the Chinese city of Xi'an. Among these aspects it will also combine the before mentioned results to other aspects such as state of wooden constructions in China and their environmental policies, to create a better view on the future scenarios regarding wood usage in China. After this it could be easier to understand the potential future opportunities of this field in China, hoping to provide relevant information for companies, organizations and others interested in this area.

## **7 Materials and Methods**

### **7.1 Materials**

The idea of increasing wooden materials in building construction in China by the people involved in this project dates to the Sichuan earthquake in 2008. Professor Paavo Pelkonen was teaching in China at the time, and the aftermath of the earthquake began to raise interest in more prominent usage of wooden construction in China.

The data for this project has been collected via a questionnaire which was filled by approximately hundred Chinese citizens, mainly from the Shaanxi province in summer 2019. The respondents were assigned to three different groups which are the following: experts (19 respondents), eco-hotel customers (52 respondents) and ordinary people (26 respondents). The average age of all respondents was 33.7 years, and 51 % of them were male and 49 % female. The experts group

consists of professors in the field of forestry as well as people working in forestry related companies in China. Eco-hotel customers are customers of an eco-hotel located in Xi'an, and the ordinary people group is formed of friends, family and acquaintances of the questionnaire distributor, all of whom have no background in forestry. The respondents were asked to answer some questions regarding the current state of wooden construction, as well as its advantages and disadvantages. But the most important questions for this thesis regard wooden samples of which either physical copies or pictures were provided for the people answering. The respondents were asked to rate different aspects of these samples, the multiple-choice questions ranged in the fields of aesthetics, durability and ethicality. Amongst these there were also few open questions where respondents could shed light on their views more freely.

During this project there has been collaboration between a Finnish non-profit association Edu Silva ry. and numerous partners including both Finnish and Chinese companies and the Northwest Agriculture and Forestry University in Shaanxi for example. All of them were provided either samples or helped in either creating or answering the questionnaire. The data for this thesis is gathered from a survey which was created in collaboration by Edu Silva ry. personnel (such as professor Paavo Pelkonen) and Northwest Agriculture and Forestry University (including professor Guangzhe Liu and master's student Jinshuang Niu). The distribution of the survey and collection of the results have been made by previously mentioned Jinshuang Niu from Northwest Agriculture and Forestry University. The wood samples were collected from Finnish companies by lecturer emeritus Antero Turkki, and he was also responsible for providing these samples to China. The analysis and examination of the data is done by the author of this thesis.

The main point of the questionnaire was rating different wood samples, of which five were used in this thesis. The five were chosen because they were answered by all the groups, as the group eco-hotel customers only reviewed these five, when instead the experts and ordinary people group had ten. The samples used in this study were named A2, A4, A5, B2 and B4. Sample A2 was "pine natural

ceiling/wall panel lacquer”, A4 was “pine floor trim transparent white lacquer”, A5 was “pine wall panel, wall décor, round trim”, B2 was “ash floor” and the last sample B4 was “birch natural, sanded and wax oiled”. For the sake of convenience, in this thesis these samples will be often mentioned by their coded name such as A2, unless it is otherwise needed.

## **7.2 Research Methods Used in This Thesis**

The research used in this thesis was mostly quantitative due to the heavy use of multiple-choice questions in the survey. The questions asked the respondents' opinion on the aesthetics, environmental friendliness and durability of the wooden samples among other traits. Examples of these questions would be statements such as “I like the color of this wood sample”, “I consider this wood sample to be climate friendly” or “I consider this wood sample as durable”, all of which are to be rated on a Likert scale. In other words, the answers were chosen from a set list of the following options: ‘Fully disagree’, ‘Disagree’, ‘Neither agree nor disagree’, ‘Agree’ and ‘Fully agree’. (Jamieson 2020.) These answers were converted to a range from 1-5, which go from first two disagreeing, third neither agreeing nor disagreeing and fourth and fifth agreeing. This offered a chance to depict the trends of the answers by statistics and charts showing the opinions of the respondents both by total amounts and percentages. This is also a preferred method for analyzing any kind of a survey with multiple choice questions (MOTV 2020). This helped us to get the rough estimate of the general opinions between the answering groups as well as a combined total between all the people that answered the survey.

The answers were also analyzed by splitting the results by respondents' gender and then comparing the trends in answers between males and females, but there were no significant discrepancies. The data was analyzed with Microsoft Excel and an open source SPSS alternative called JASP. In this thesis the data was depicted with charts made with Excel so that it was easier to see the contrasts between the positive and negative opinions.

Among having Likert type questions, the questionnaire had open ended questions. Therefore, this thesis will also use qualitative means of analyzing. Qualitative



research methods differ from quantitative in that they are much more open to interpretation compared to its counterpart. Instead of raw data that quantitative research often offers, qualitative research often provides opinions and broader answers open to interpretation by the researcher (MOTV 2020). Because of this I would consider it as a perfect supporting measure for otherwise very quantitative-heavy study, like this thesis for example. In this work the information provided by qualitative methods will be used to support the data that was shown in the quantitative research and among that, to open more accurate meaning behind the answers. An example of this could be if one of the samples has a lot of negative answers in the “I like the color of this wood sample” -field, it is easier to find out the reasons why it is viewed as such when looking at the open answers provided by the respondents. As an example, they could have provided a comment if the sample has some specific aesthetic qualities that they dislike. The open answers have been grouped in 3 categories in the data analyzing phase, which were aesthetic, ethical and durability/special properties. The answers were categorized regarding which of the three fields the comments were most suited, if the comment was more comprehensive and it delved into multiple sections, then that answered was marked in all of the categories it suited. The answers and comments for open-ended questions that are being talked about in this study are either ones that came across in multiple answers by different people, or were more rare, but offered interesting or important insight in analyzing the reason behind why the wood sample was viewed the way it was in the big picture.

The perceptions looked at in this study range from visual preference of wood used in surfaces of domestic areas, other preferred properties when considering what kind of wood to use in their homes, what do the respondents saw as both the advantages and disadvantages of wooden construction in general and how the rated samples could be improved. All the answers were analyzed in their separate categories of qualitative and quantitative data. These results and findings were also bound together and with the help of aspects such as history and social factors, more accurate and coherent answers were received, with potential reasoning why certain perceptions were the way they were and how they should have been noted. Thus, making the base assumptions and conclusion of what traits in these wood samples would be the most desirable in the Chinese market.

## **8 Results from Likert Type Questions**

### **8.1 Healthiness, Eco- and Climate-Friendliness of the Samples**

Starting from the results that were unanimous between the respondent groups, and even between samples, were that the samples are eco-friendly, climate-friendly and healthy. Out of the 97 people partaking on this questionnaire, at least over 60 %, and often almost 70 % agreed with the previously mentioned statements, meaning they answered either agree or fully agree (Figures 1, 2 and 3). People who disagreed with the statement that answered either 'fully disagree' or 'disagree' didn't exceed over 5 % when looking at the total amount of answers, and even in single respondent groups the amount of disagreeing answers did not exceed over 6 %. Probably due to the questions considering the same rough area of environment and health, the ratios of answers between these 3 questions followed very similar lines. There was only little variance between the percentage of answers comparing these 3 to each other which can be seen when viewing figures 1, 2 and 3 below.

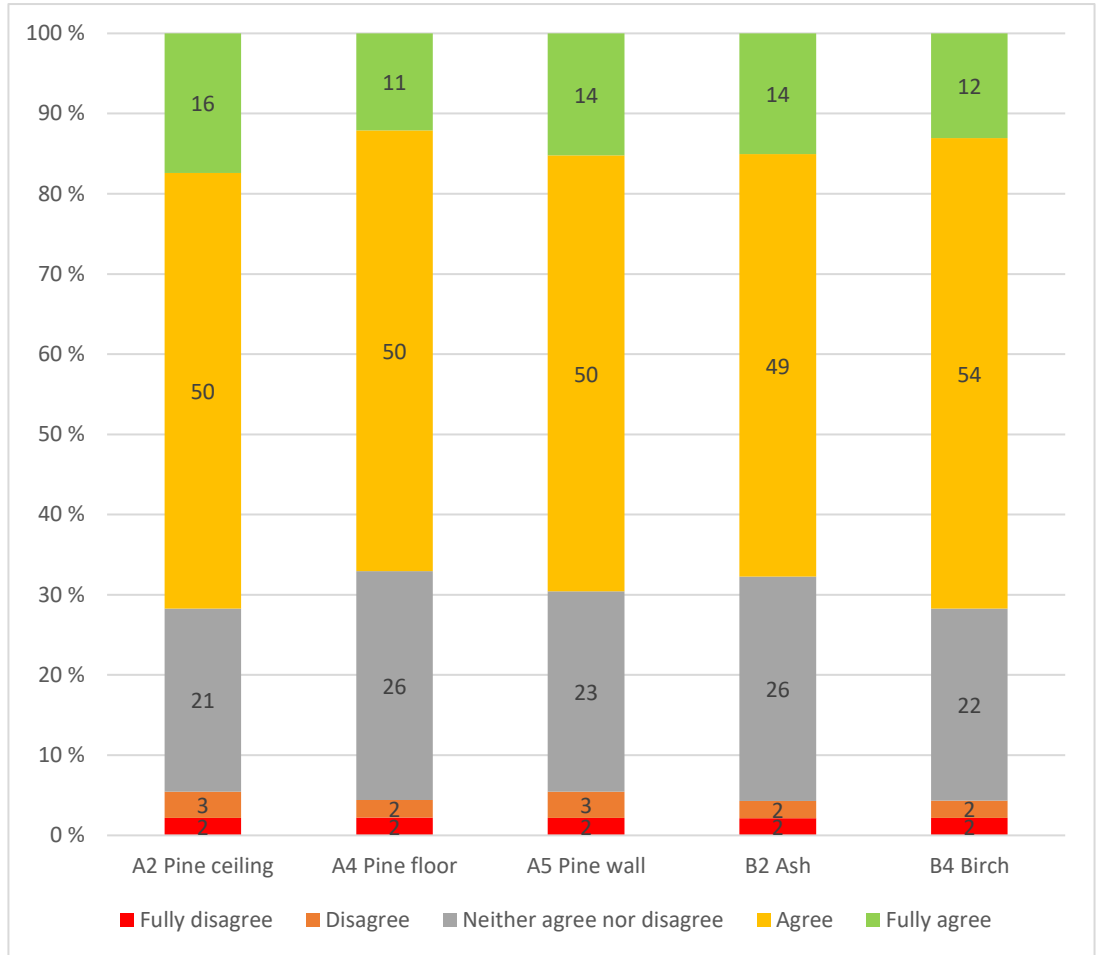


Figure 1. Results from “In residential housing context, I consider this wood sample as healthy”

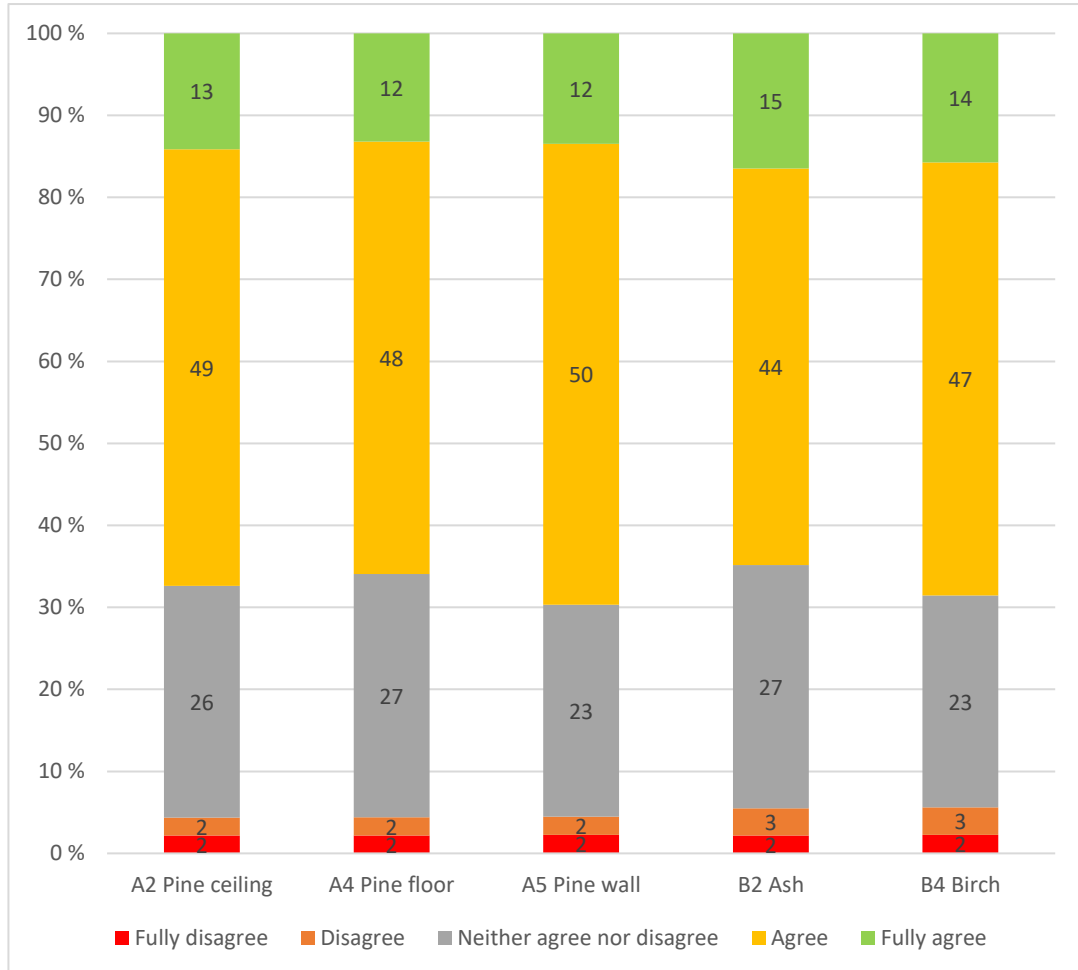


Figure 2. Results from “In residential housing context, I consider this wood sample as climate-friendly”

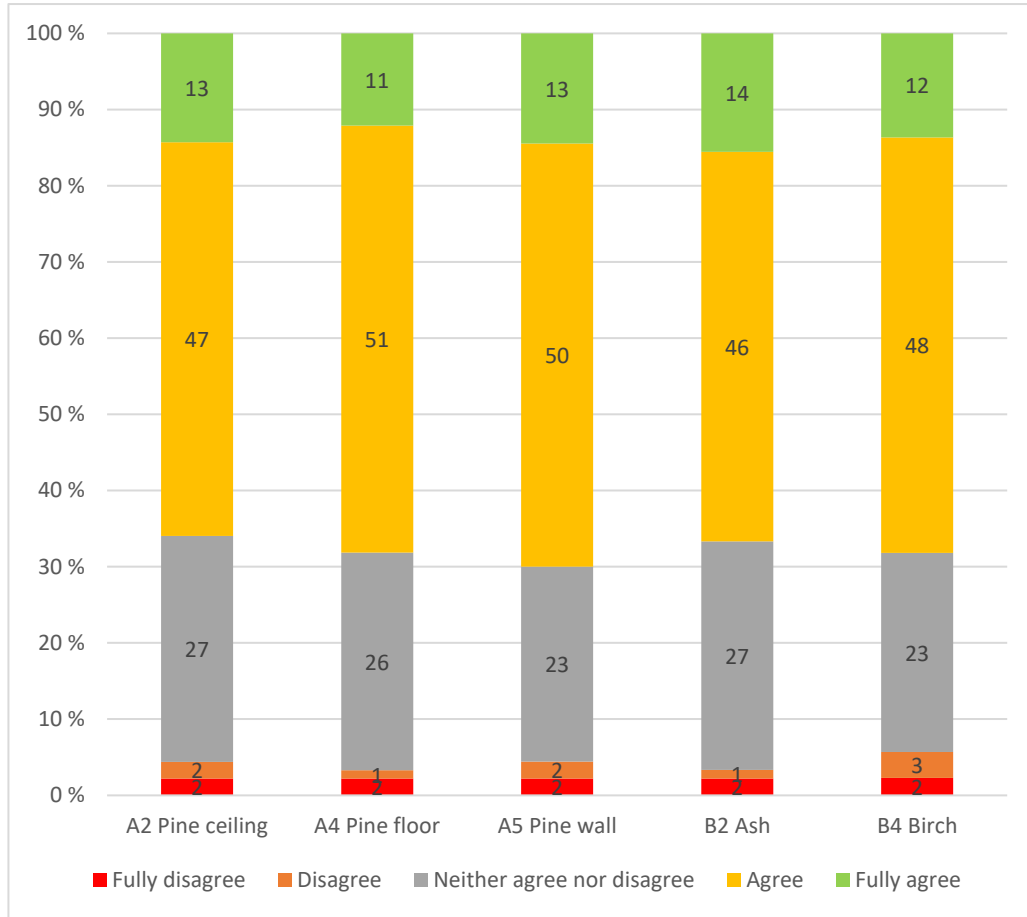


Figure 3. Results from “In residential housing context, I consider this wood sample as eco-friendly”

## 8.2 Aesthetic Elements and Color Preferences

While rating the color of the sample, the ‘expert’ group gave the most agreeing answers, while the ‘ordinary people’ group was the harshest by giving the least (appendices 1,2,3 and 4). Especially considering the color preference this was the case every time, except when rating sample A4, where ‘eco-hotel customers’ had the largest percentage that agreed with liking the color of the wood sample (appendix 1). Generally, the most preferred colors were possessed by the three pine wood samples: A2, A4 and A5 instead of the more brightly colored ash wood sample B2 and the birch wood sample B4. From the pine wood samples A2, or ‘pine natural ceiling/wall panel lacquer’ the color was seen as the most favored

one. In a grouping of 97 people 63 % gave it an agreeing answer to “I like the color of this wood”, and only 12 % of the people disagreed. The second most liked sample was A5 - ‘pine wall panel, wall décor, round trim’ that had an agreeing answer 60 % of the time and disagreeing by 9 %. The last of the pine wood samples was A4 - ‘pine floor trim transparent white lacquer’ that had a rate of 48 % on positive answers, and 17 % on negative ones. Out of the light-colored wood samples of B2 - ‘ash floor’ and B4 - ‘birch natural, sanded and wax oiled’, B4 had the most preferred color with 41 % positive and 25 % negative rating. But still falling noticeably behind of the least liked color of pine wood samples which was A4. On the other hand, B2 had only 36 % of the respondents agreed on the color being likeable, with 23 % disagreeing. (Figure 4) With this sample the biggest difference maker comes from the group ‘ordinary people’, of which only 12 % liked the color of the wood sample while 37 % disliked (appendix 3). It is also worth noting that the expert group had very different answers on this than the other groups, as they agreed with liking the color of sample B4 by 73 % and disagreeing by 10 % (appendix 4). This is the largest discrepancy between one group’s pattern in answers compared to others. Considering that the ‘experts’ group seems to rate all the other wood sample colors more positively than others, the only exception being sample A4 (appendix 1), and that the expert group is also the smallest of all the groups with it having only 19 participants, it might not be smart to put too much weight on this observation.

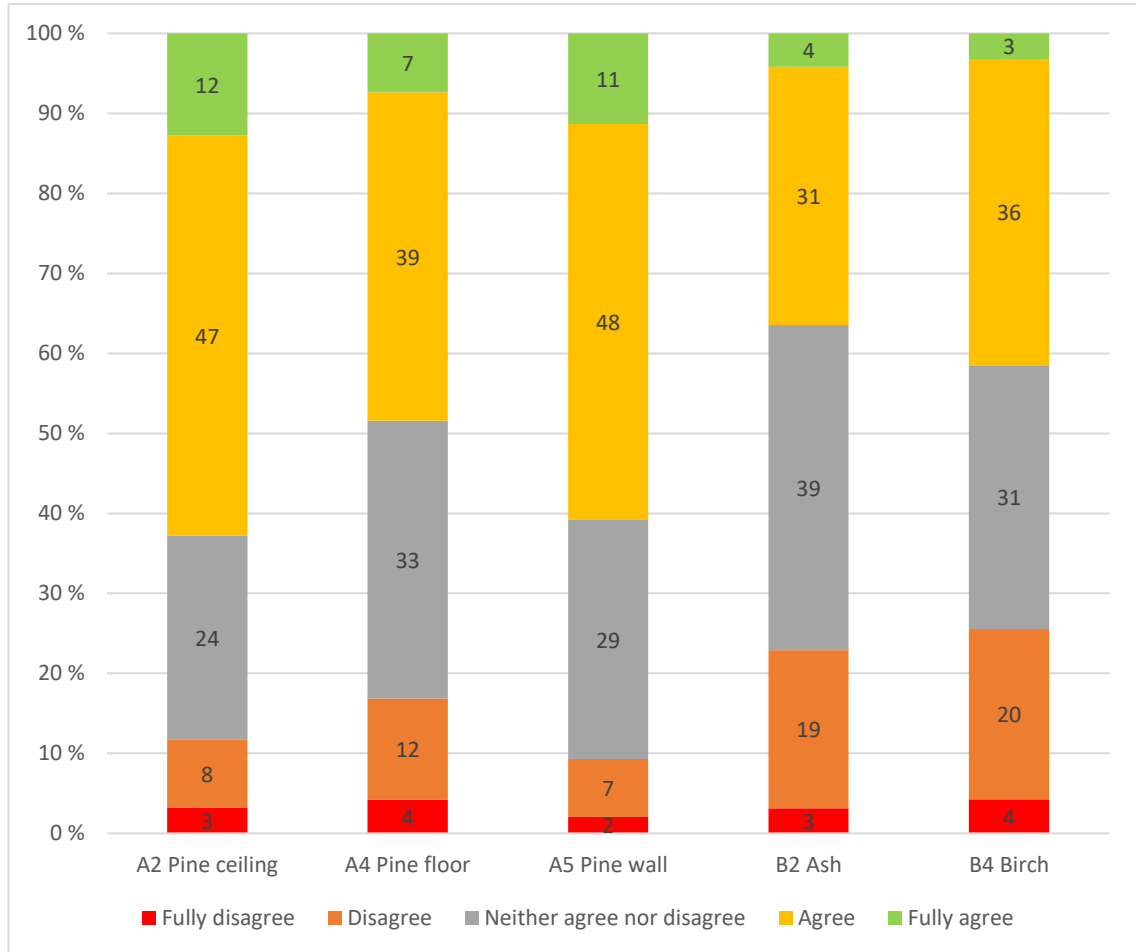


Figure 4. Results from “I like the color of this wood sample”

When asked the question “I consider this wood sample as aesthetic”, the A2 sample was again the most liked. Out of the people who answered 70 % agreed with the statement, and only 7 % disagreed. Between the rest of the two samples A4 and A5 the answers were very even. This time A4 was viewed more aesthetic, as 68 % of the respondents agreed and 4 % disagreed with the statement, compared to A5’s 66 % agreeing and 6 % disagreeing. Aesthetically the views on light colored wood samples did not differ greatly from the darker pine tree samples. And when considering the aesthetic quality, B2 was the preferred one with 67 % of people agreeing, and only 6 % disagreeing it being aesthetically pleasing. Whilst B4 also had an overall positive rating of 60 % and negative opinion was given only by 9 % of the respondents. In this case these samples fall behind on the average given to pine wood samples. But when rated head to head,

B2 was viewed as the more aesthetic sample than the lowest pine wood sample A5, though the difference with B2 being better than A5 was only by 1 % on agreeing answers and 0 % with disagreeing. Similarly, another low difference was between B2 and A4, with the agreeing answers differing by only 1 % for the side of A4, and negative answers being 2 % lower with the sample A4. (Figure 5)

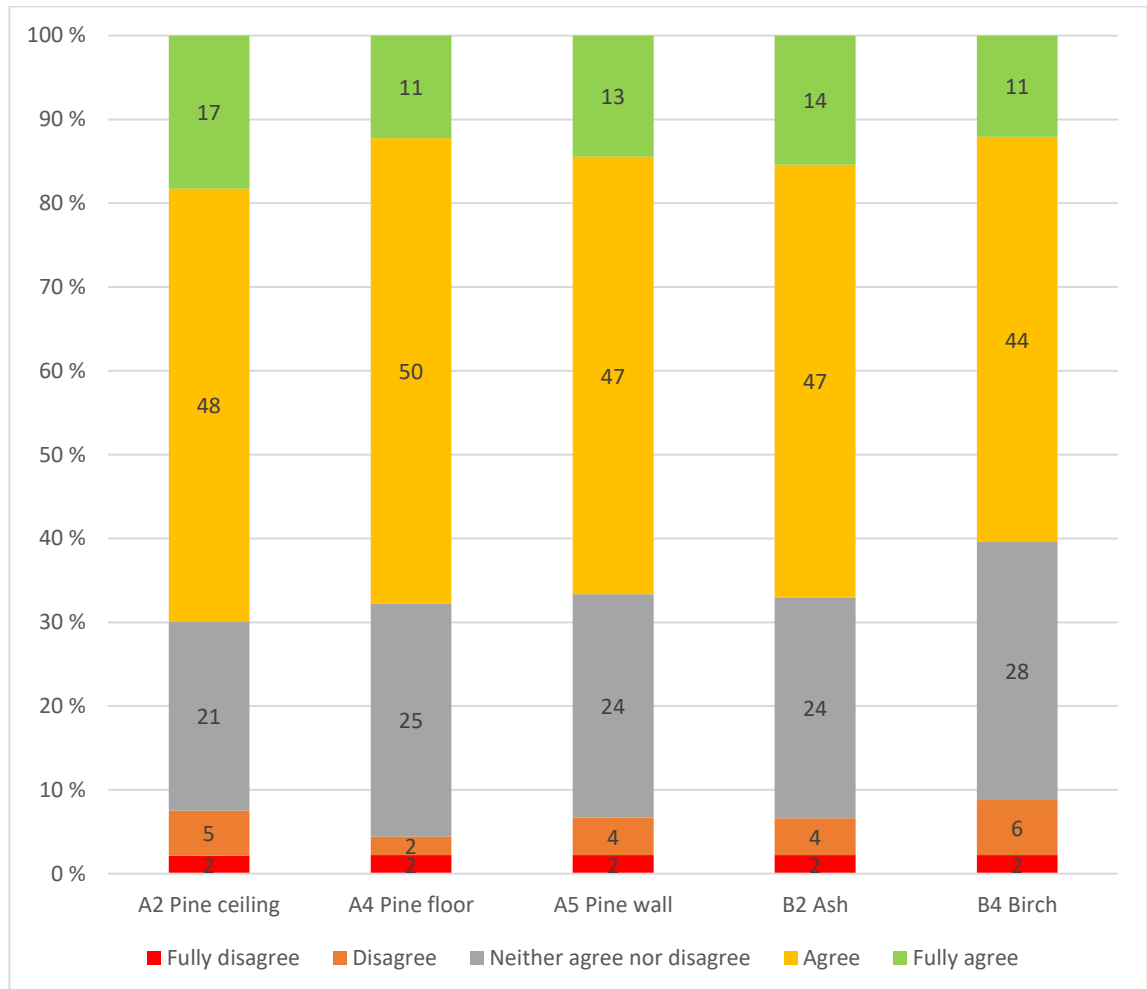


Figure 5. Results from “In residential housing context, I consider this wood sample as aesthetic”

### 8.3 Anticipation of Costs Related to Use in Residential Housing

Like in previous aspects, the pine wood samples were seen expensive more often than samples of ash or birch wood. Samples A5 and A4 were both seen as



expensive by 57 % of the respondents, but 15 % of respondents fully agreed with A4 being expensive compared to 13 % by people rating the sample A5. A4 also had fewer people disagreeing with it seeming expensive by only having 6 %, while A5 had a share of 7 %. The third pine wood sample A2 was not far behind the top 2 samples. The statement proposed in the question had been agreed with 56 % of the time and disagreed with by only 6 % of the respondents. It is worth noting that sample A2 had the highest rate of respondents checking the 'fully agree' box with 17 % choosing that answer. The differences between these 3 samples are very small when the highest and lowest viewed had only 1 % difference in overall agreement, and 3<sup>rd</sup> sample A2 having more people fully agreeing on it having an expensive appearance than the 1<sup>st</sup> sample A4. Therefore, even though it can be viewed that A4 is the most favored of the 3 pine wood samples. the difference is not exactly huge.

As previously mentioned, the lighter colored wood samples of ash and birch had again lower ratings than their pine wood counterparts. Sample B2 was viewed as expensive by 55 % of the respondents, and notably 14 % of the respondents fully agreed with the statement, making it the sample with second highest total in 'fully agree' answers. Although it had a disagreeing answer 9 % of the time, which is the shared highest amount of all samples with the birch wood sample B4. Sample B4 had agreeing answer rate of 54 %, the lowest of all samples. Even though sample A2 gets relatively close to the lowest rated pine wood sample A2, only falling behind 2 % with agreeing answers, the negative rating of 9 % compared to A2's 6 %. Therefore, it is safe to say that even though there could be arguments made about in which order the two remaining pine wood samples A5 and A2 should be placed after A4, the last 2 samples should be B2, and B4 respectively when ranked highest rated to lowest in the category of whether the sample looks expensive. (Figure 6)

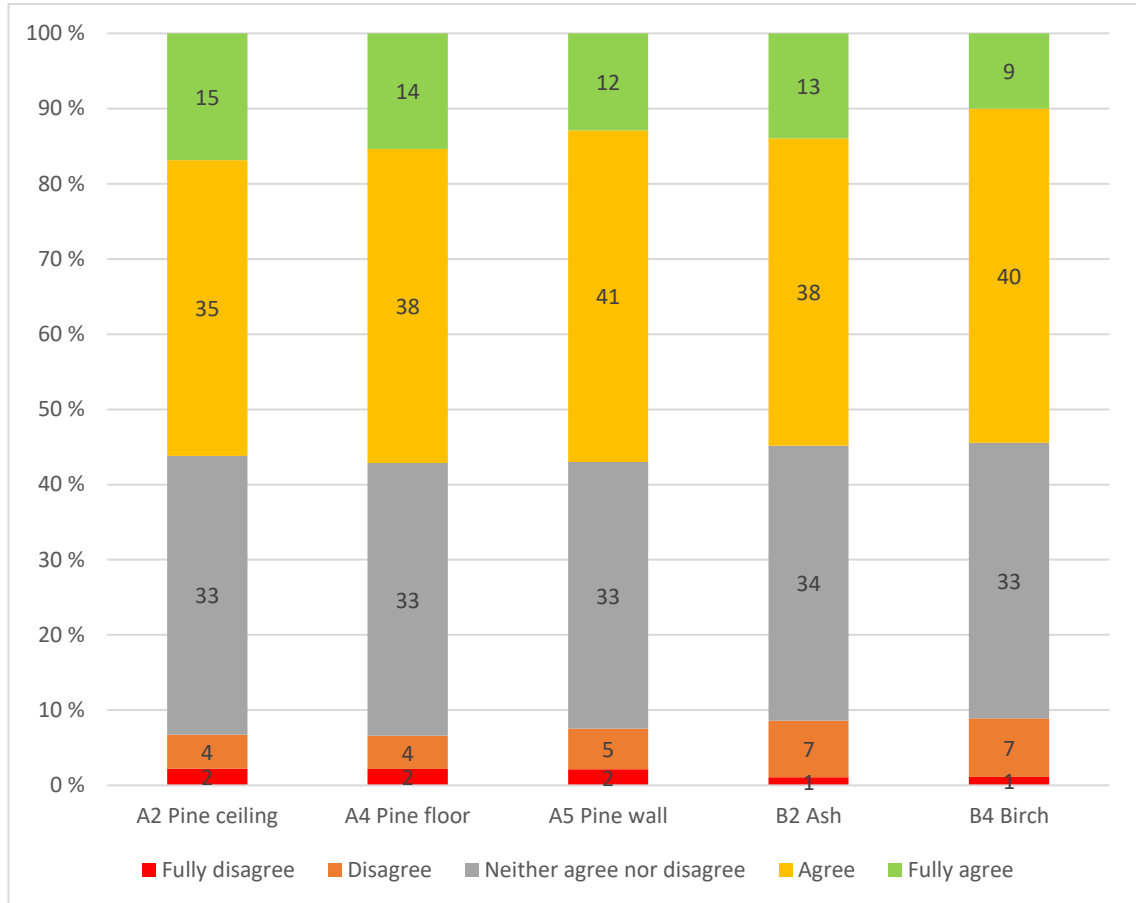


Figure 6. Results from “In residential housing context, I consider this wood sample as expensive”

#### 8.4 Modernity

Sample A4 is also considered as modern more often than the other samples. With 59 % of people agreeing with the statement in the question and 8 % disagreeing. Similarly, to the rating in expensive category, the second place goes to sample A5. Among the people who answered the questionnaire 56 % viewed the sample as modern whereas 9 % of people disagreed. A2, on the other hand was rated positive 55 % of the time and had a negative rating of 11 %. The differences in this category are more evident than the ones in ‘expensive’ category, and therefore it is in my opinion possible to rank these samples by A4 being the highest rated and A2 the lowest rated. The results in whether the samples appear modern to the respondents of the questionnaire, the light-colored wood samples

switch places, with B4 being viewed modern more often than B2. B4 having 57 % of respondents agreeing with it looking modern and 9 % disagreeing. Comparing this to sample B2 that only had rating of 53 % positive and 12 % negative. When comparing these results to the pine wood samples, B4 takes the overall second place in being the most highly viewed. Although the difference between it and A5 being only 1 % with people agreeing with the statement, and A5 having 13 % of the respondents going for 'fully agree', instead of 11 % with the people rating sample B4. Even though this difference is very small, the gap between the 4<sup>th</sup> sample is more noticeable so it should be noted that in this category the birch wood sample fairs very well against the other four, making this category one of the rare ones where brighter colored wood sample gets close to the top. Therefore, when ranking these five samples from the most modern looking to the least, the order should be something like this: A4, B4/A5, A2 and finally B2. (Figure 7)

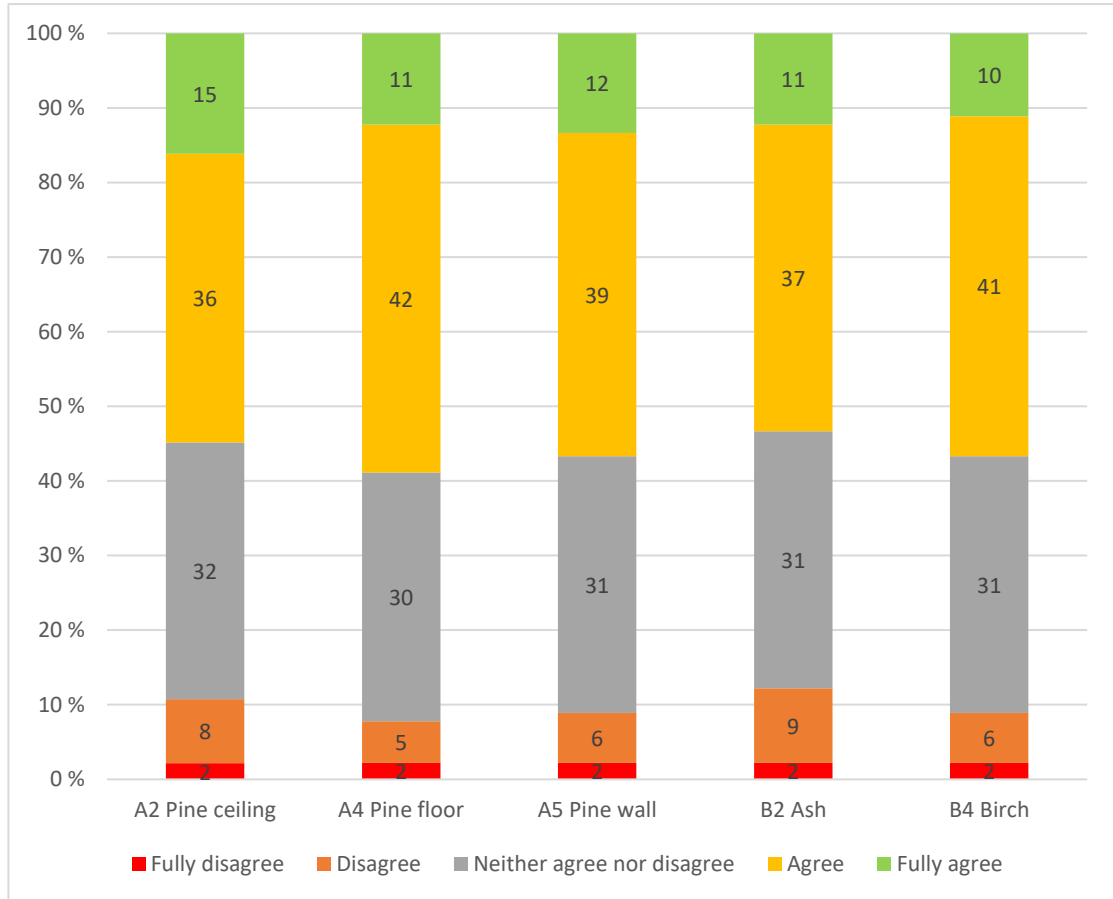


Figure 7. Results from “In residential housing context, I consider this wood sample as modern”

## 8.5 Durability

When answering the questionnaire, the evaluation of samples durability was not exactly very thorough, but the respondents were provided samples they could rate by eye and feeling the surface of the wood by hand. The answers between samples were quite even, ranging from 55-60 % positive and 6-13 % negative.

Considering that pine wood is categorized as a soft wood, whereas birch and ash are hard woods, the difference between the latter two and two pine wood samples A2 and A5 were surprisingly even when looking at the rate of answers that saw them as durable. Starting from the hard wood samples, the B2 ‘ash floor’, was considered durable by 60 % of the respondents and not durable by 6 %. The

sample B4 'birch wood natural, sanded and wax oiled' was seen as durable by 58 % of the survey fillers, whilst 8 % of the respondents didn't agree with this. The softwood samples made from pine tree had slightly more varied ratings. Samples A2 'pine natural ceiling/wall panel lacquer' and A5 'pine wall panel, wall décor, round trim' both received a 60 % rating between all respondents. But in the case of A5, 11 % disagreed with this, when A2 only had a 9 % disagreeing with it being durable. Sample A4 'pine floor trim transparent white lacquer' was viewed as the least durable out of all softwood samples, which meant it had the lowest rating overall. Somewhat close to 55 % of questionnaire respondents considered it being durable and 13 % disagreed, with the latter being considerably high number when comparing it to other samples. As the rating of samples A5 and B4 are quite similar with A5 having 2 % more agreeing it with it being durable, but on the other hand also having 3 % more people saying it is not durable. Then considering the sample size of this study, this difference could be viewed as numbers of people who voted instead of as a percentage share. As 91 out of the possible 97 people rated the sample A5, and 92 out of 97 rated the sample B4, both the 2 % and 3 % swings are 2 people. This means that 2 more people see A5 as durable, but at the same time 2 more people see it as not durable. Thus, in my opinion these two samples should be viewed to be on equal level in the rating, and that the rating of samples considered to be most durable to least durable be the following: B2, A2, A5/B4 and A4. (Figure 8)

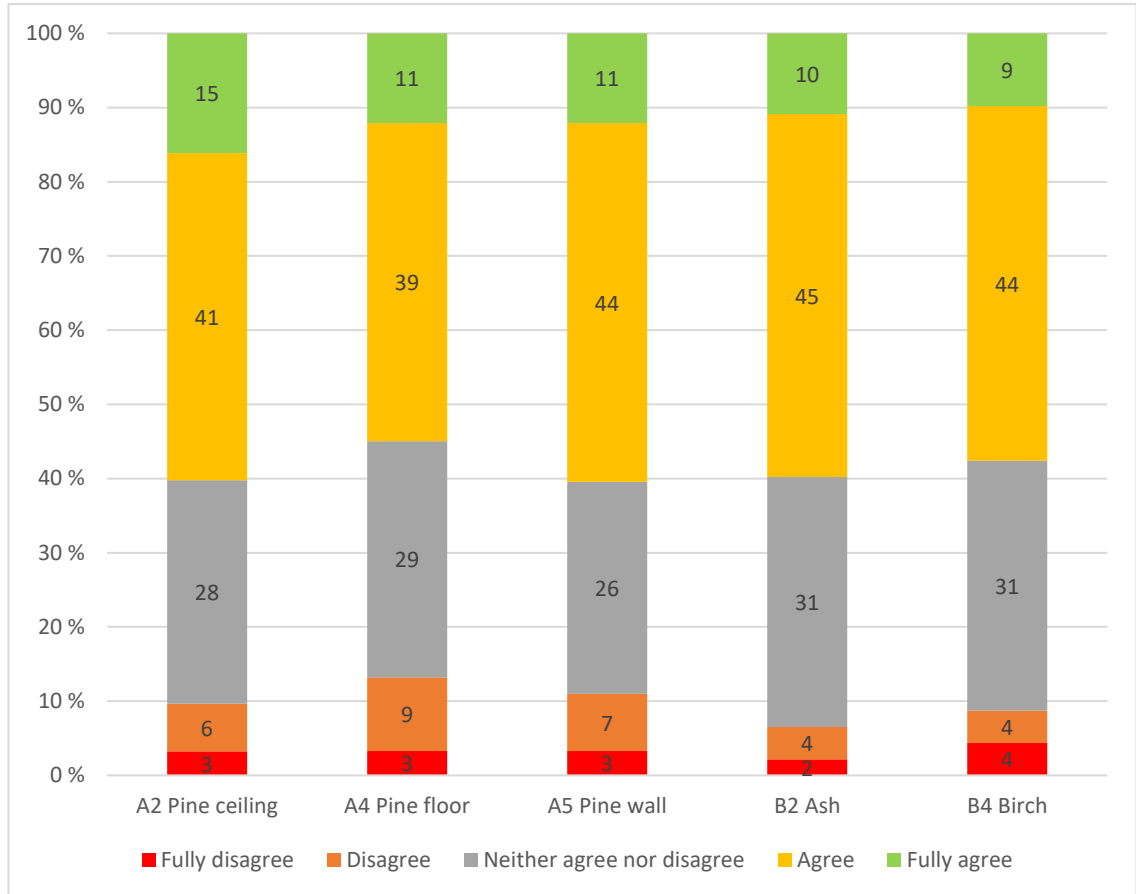


Figure 8. Results from “In residential housing context, I consider this wood sample as durable”

### 8.6 Used as a Material in Own House, or in a Hotel

The two proposed statements “I would like to use this kind of wood in my own home” and “I would like to see this kind of wood in hotels where I stay” were answered only by two groups out of three, with the respondents being the groups ‘ordinary people’ and ‘eco-hotel customers’ with ‘experts’ group left out. Therefore, the maximum amount of answers per question drop down from 97 to 78.

When respondents considered whether or not they would like to see certain type of wood from the samples provided in their own homes, the answers followed the familiar trend from previous categories where darker pine wood was preferred

over the brighter colored wood samples of ash and birch. The most wanted sample was A2 'pine natural ceiling/wall panel lacquer', 55 % of the respondents would like to see it in their own homes whereas 18 % wouldn't. The second most desired sample was A5 'pine wall panel, wall décor, round trim' that had 51 % of the people agreeing with the statement and 13 % disagreeing. The third one and final of the pine wood samples, A4 'pine floor trim transparent white lacquer' had the first sub-50 % rating of 46 % of people wanting to use it in their own house with 14 % of the respondents clearly not wanting to use it. Second least liked sample was B2 'ash floor', of which only 35 % of the questionnaire respondents would like to use in their own home, with as many as 29 % not wanting to use it. Finally, the last sample was B4 'birch wood natural, sanded and wax oiled', that only 29 % of the people answering would want to see used in their own house with 36 % answering negatively. This sample is also the first one that receives more disagrees than agrees. (Figure 9)

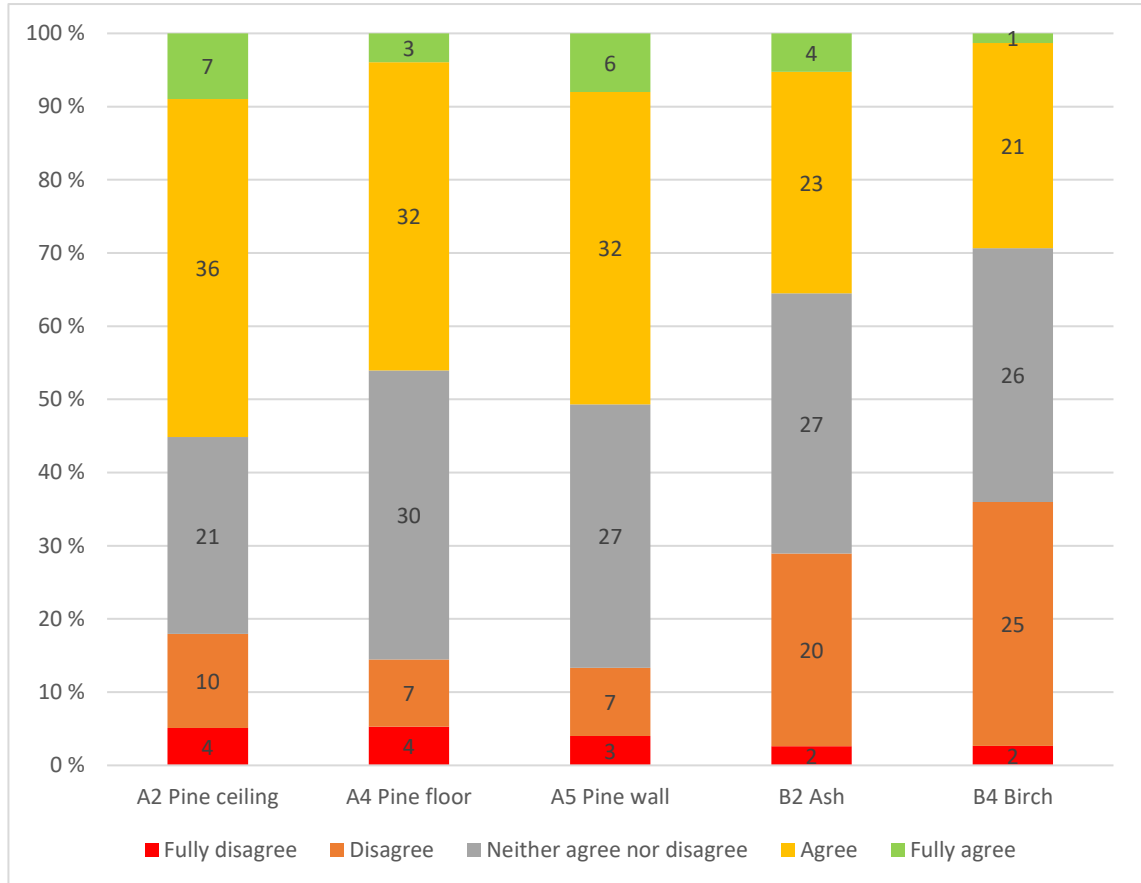


Figure 9. Results from “I would like to use this kind of wood in my own home”

As for these wood samples to be used in hotels the answers were very similar to the previous ones, even to that extent that the samples rankings from the most favored to the least were the exact same: A2,A5,A4,B2 and B4 respectively. Of the pine wood samples, A2 was commonly viewed as a good material to be used in hotels with 49 % agreeing it to being suitable and 12 % disagreeing. The numbers for A5 were 47 % agreeing and 11 % disagreeing. A4 was again the last of the pine wood samples with it receiving a positive answer 39 % of the time and a negative 11 % of the time. From brighter wood samples B2 was considered as a good choice as a material used in hotels by 33 % of the respondents and undesirable by 17 %. Lastly there is the sample B4, only 32 % of people who answered the questionnaire would like to see it in hotels they visit and 22 % would not. (Figure 10)



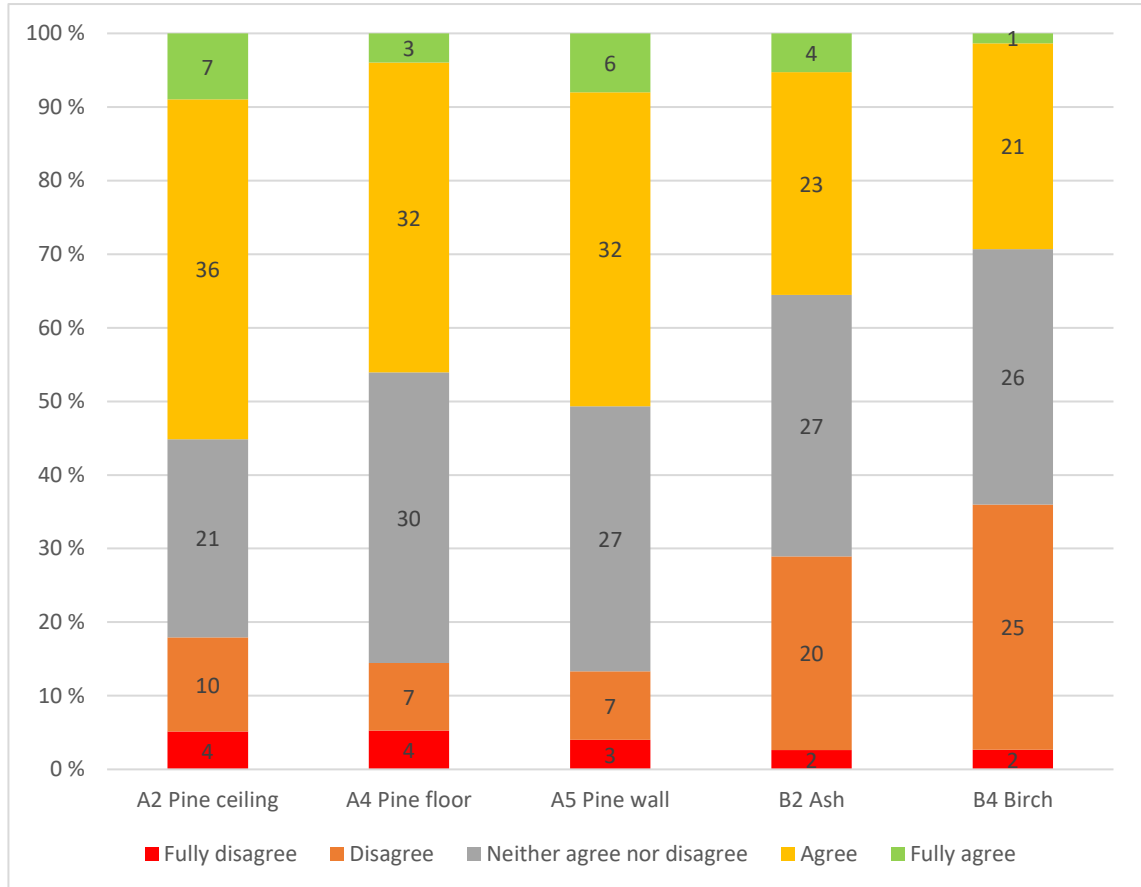


Figure 10. Results from “I would like to see this kind of wood in hotels where I stay”

## 9 Results from the Open-Ended Questions

### 9.1 Qualities Associated with Each Wood Sample

When first analyzing the questions from the largest respondent group, ‘eco-hotel customers, it can be viewed that the most commonly placed attributes for all the samples are “beautiful”. “natural”, “durable” or “solid” and “environmentally friendly”. The terms “beautiful” and “durable” were more often used in the pine wood samples A2, A4 and A5. Whereas terms like “natural” “solid” and even “environmentally friendly” appeared more under the ash wood sample B2 and

birch wood sample B4. Pine wood samples received few negative comments, which were on the line of the material being of not good quality or in the case of sample A5, it's easy to deform. These negative comments were far outmatched by positive qualities given to them. When rating the sample B2, some of the more unique comments it got were qualities such as "waterproof" and "clean". It was also the sample that was commented on being "environmentally friendly" the most often. The qualities of B4 were most often types of "solid", "strong" or "clean".

The second largest group was the group 'ordinary people'. The answers were fairly similar with the previous group. With pine wood sample A2 being considered "beautiful" more often than others, and samples A4 and A5 either "hard" or "solid" as well as A5 again being commented to be "easy to change", referring to the structure of the wood sample. Hard wood samples were considered to have qualities such as "strong", "smooth and "bright", with sample B4 getting more praise on its' visual qualities than B2. But they both also got associated with some negative comments such as "plastic" and "easy to catch fire".

The third group 'experts' although being the smallest group of the three, provided much more specific answers for the open questions making it easier to analyze and connect to previous results of the Likert scale questions. Also, in this group there were fewer people who left open questions unanswered than those from the 'ordinary people' group. Similarly, as with the other groups, the 'experts' group also gave more praise to the pine wood samples, with them being associated with qualities such as "natural", "comfortable", "healthy" and "warm" more often than ash and birch samples. The sample A2 was also commented on having "good texture" or "good characteristics" as well as being very suitable for decoration. A4 was seen to have qualities such as "waterproof" and "light". The final pine wood sample A5 was commented to be "durable", "environmentally friendly" and "comfortable" or "warm" more often than the others. The ash wood sample A2 had the fewest amount of comments, but they were still positive such as "natural", "comfortable" or "beautiful pattern". The birch wood sample A5 was associated with "natural", "pure" or "bright" qualities.

Putting all these answers together it could be said that pine wood samples are considered by respondents to be especially beautiful, durable and solid. Hard wood samples instead were more often said to be bright and strong. Some terms that were thrown around for samples in all groups were “environmentally friendly”, “healthy” and “natural”. Some sample specific qualities were for example “durable” for the sample A2, “waterproof” for the sample A4, “natural” for the sample A5, “clean” for the sample B2 and “smooth” for the sample B4.

## 9.2 Improvement Suggestions

One of the other open-ended questions related to the samples was in what way they could be improved to seem more desirable to the respondents. Again, starting from the most populous respondent group ‘eco-hotel customers’, they had the most improvement suggestions for the brighter colored hardwood samples B2 and B4. According to the respondents they shared a lot of the same faults, mainly considering the look and feel of the sample. Most often given improvement aspects relating to the look of the wood were “it should be darker”, “increase beauty”, “color is too white” and other comments relating to the pattern of the wood. Considering the surface of the wood the improvement suggestions were about making it smoother, easier to clean, smoother and using less glue. The latter also had environmental worries related to the usage of glue on sample B2. Among these, the fire resistance ability of both samples was also questioned. The improvement suggestions were much fewer for pine wood samples, but they followed the same path as the ones regarding the hard wood samples. All three had comments regarding their color, such as “enrich the color” or “the color should be darker”, these were by far the most common ones. On sample A2 there were few comments proposing that “texture” or “smoothness” should be improved, and for A4 the suggestions were about “improved material/material quality” and “carving” the sample. For the sample A5 “waterproof coating” was suggested on few occasions.

The answers by the group ‘ordinary people’ were very simple and short, and they concerned mostly the visual aspects of wood samples. For pine wood samples

A2 and A5 the most common improvements suggested were about making the wood “darker” or adding “more color”. On samples A2 and A4 there was a comment about the flexibility of the sample to be improved. Sample A4’s visual fault was mostly about too “simple” pattern and “various texture” should be added. For brighter colored wood samples made of ash and birch, the main faults were also in the color of the wood. Sample B2 was “too bright” and “pattern” should be improved. Similarly, sample B4 received comments that the color should be darker, and it should have “more pattern”.

With the ‘experts’ group the suggestions between wood samples were much more even, though the hardwood samples got one or two more suggestion improvement than the softwood ones. For pine wood samples the suggestions were again about color or quality of the wood, but instead asking it to be darker, it was either “color should be clearer” or “whiter”. A common suggestion between these samples was also that the “texture” should be improved. For samples A2 and A5 more environmentally friendly coating or treatment was requested. Answers for ash and birch samples were mostly about the look of the sample. For example, for sample B2 color was said to be “too dark” and requested to be more like “pure wood”. B2 also had few wishes about quality or durability of the sample to be improved. B4 had some comments that “the color is too light” as well as “diversify pattern/color”, but it also had comments saying the “pattern should be clearer” and that the “birch texture should be more obvious”.

### **9.3 Wooden Construction and Décor**

One of the open-ended questions that are not related to wooden samples looked at in this thesis is the respondent groups opinions and imagery considering wooden construction and décor. This question was only given to groups ‘eco-hotel customers’ and ‘ordinary people’. For the ‘experts’ group this question was replaced by “What do you consider as the major driving forces of wood construction?”.

The imagery given to the 'eco-hotel customers' group is largely about the aesthetic, environmental and health aspects of wood used in construction and decoration. Adjectives such as "beautiful", "natural", "environmentally-friendly", "healthy" and "artistic" were some of the often-given answers. Among these, phrases along the lines of "feeling of returning to nature" and mentions of wood being "sustainable" as well as about the "aroma" given by wood were also encountered in the answers. Comments regarding durability, or other properties of wood used in building were scarce, but resistance to corruption, being waterproof, seismic stability and heat insulation were mentioned.

The answers of 'ordinary people' group were spread out amongst aesthetic, environmental views, as well as views related to properties of wood. Again, terms such as "beautiful" and "environmentally friendly" were common, but there were terms such as "light" and "portable" that were not in the answers of eco-hotel customers. Some qualities such as earthquake resistance, heat preservation and being healthy were mentioned here similarly to the 'eco-hotel customers' group.

#### **9.4 Advantages and Disadvantages of Wooden Construction**

In the questionnaire people were also asked to answer their opinions regarding the advantages and disadvantages of wooden construction. This part will also go through the question given to 'experts' group that asked: "What do you consider as the major driving forces of wood construction?", as well as the question given to all groups where they were free to provide other comments regarding wooden construction without specific limitations.

In 'Eco-hotel customers' group the most often given answer for advantages of wooden construction were about the look of a wooden building or décor, such as "beautiful" or "natural". Other common answers were "non-pollution" or other comments regarding environmental friendliness as well as "convenient", "safe", "healthy" and "retro". Other comments that were given were that wooden

buildings are naturally good insulators and are of higher quality. It was also mentioned that “there is Chinese traditional beauty” in wooden buildings.

According to the answers provided by the group ‘ordinary people’, the biggest advantage of wooden buildings is their appearance and environmental friendliness. As it was the case with the group ‘eco-hotel customers’, the most common used adjective in the advantages was “beautiful”. After that the second most common one was “environmental-friendly” with “comfortable” and “portable” also being repeated.

The answers given by the final group ‘experts’ differed from the others in that most of the advantages were about woods properties, with environmental aspects being the second. The most commonly mentioned advantages were insulative properties such as being able to stay “cool in summer but warm in winter”, as well as being safe against seismic movements and being “energy efficient”. Other advantageous properties were said to be “short construction period”, “light”, “environmentally-friendly”, “being comfortable” and “giving people a feeling of kindness” as well as the previously often given answer of “beautiful”. The ‘experts’ group was also asked about what they consider to be the major driving force in wooden construction, and their answers were very similar with each other. Elements such as “promotion of green lifestyle”, “need of comfortable and pleasant environment”, history of wooden building in China and “relevant policies of the state”.

When compiling all the advantages together, it is seen that the most often viewed ones relate to the aesthetic elements of wooden construction such as beauty, as well as to it having the image of being the embodiment of environmentally friendly building. Another property that slots close to this field is the effect that wooden buildings have on people, they are considered as “healthy” and “comfortable” with occasionally referenced to providing a feel of “returning to nature”. The historical aspects of wooden buildings in China also seem to give it a positive image, as it is seen as traditional and thus providing a unique charm compared to other

building methods. From other aspects, wood being a considerably light building material and thus being easy to move to construction sites is another often seen advantage.

Among all answers given by all groups, each of the given disadvantages, except one, were about the durability of wooden buildings or properties of wood used in buildings. The most common worries regarding wooden buildings were that building them is too expensive, they are not fire- or waterproof, they suffer from damage caused by pests, they are not strong enough or wood can't handle weight the same way as concrete and that wooden buildings have short life cycles. In the 'experts' group some disadvantages about building and architecture were given, such as "the building characteristics are limited by the characteristics of the wood itself", "the mechanical properties are bad" and that buildings made from wood "can't be built too high". The single non durability related disadvantage was that according to the respondent, wooden buildings "waste resources and destroy the environment".

## **10 Constraints and Problems Encountered During the Study**

Some of the questions presented in the questionnaires (appendix 6 & 7) are not being analyzed in this thesis due to them being reserved for a larger overall research of the subject. With this, due to practical reasons only the 5 samples reviewed by all questionnaire respondent groups are being analyzed in this thesis. The total amount of wooden samples was ten, of which the five extra samples were reviewed only by the experts and ordinary people groups. As the survey was given to 97 people who were classified among 3 groups which were experts, eco-hotel customers and ordinary people all of whom are mostly located in the Shaanxi province, this survey cannot give a comprehensive view of the general opinion among all Chinese people. Instead this should be used as an example and as something that provides a general and a rough estimate, that can be used to create estimates and possibly to apply into further hypotheses. Another one of

the constraints of this study was the sample size in experts and ordinary people groups, with the first one being 19 people and the second one 26 people. Therefore, when looking at the percentual differences in these two groups, minor variance is to be expected, and thus unless there is noticeably large differences, these results cannot be relied on too heavily when viewed as singular groups especially with the Likert type questions, but they provide a good addition when compiling all the answers together with the answers from other groups.

Some of the problems encountered during the data analyzing phase spawned some improvement ideas for upcoming studies following the path of this one. Two of the three groups, experts and ordinary people, were given ten wooden samples to be reviewed whereas eco-hotel customers were given only five. The samples were in order A1-A5, followed by B1-B5. The samples given to eco-hotel customers were A2, A4, A5, B2 and B4. When rating as many as 10 samples, all of them having 10 Likert type questions and some open-ended ones, it is bound to become tiring, which can be seen in the growing amount of people leaving answers as blank towards the final samples, especially in the open-ended questions. Therefore, to maximize the answers received for samples rated by all groups, these samples reviewed by eco-hotel customers should have retrospectively been given as the first five ones to other groups instead of spreading them out.

Another improvement idea is about planning the placement of the questions in the questionnaire. Mainly the statements "I would like to use this kind of wood in my own home" and "I would like to see this kind of wood in hotels where I stay". These were placed as the second and third questions out of ten, following the question "I like the color of this wood". Seeing how the results of these two questions are directly rated to the result of how likeable the color was seen, there might be the case that elements such as durability, aesthetics or how modern the sample was seen were not being weighed in as much because they were presented later during the questionnaire. And as these two questions regarding the wood's usage in a residential element could be considered as the most important ones in this study, it would have been better to place them as the last two ones.



## 11 Discussion and Conclusions

### 11.1 The General Perceptions

According to this study, the most desirable wood in the market area of Shaanxi would be pine, or other darker woods instead of brighter ones, if they were to be used on visible surfaces. Especially the samples A2 'pine natural ceiling/wall panel lacquer' and A5 'pine wall panel, wall décor, round trim' were the most desired ones, and had highly rated properties. Seemingly, the most important quality regarding whether they would like to use wood similar to the sample in their own house, or see it in a hotel was its color, and the most often given improvement suggestions regarded the samples aesthetic qualities such as beauty or pattern of the wood. The darkness of the wood was a factor in whether the samples color was liked or if they were considered expensive or not. The slightly darker colored pine tree samples were at the top both times, whereas the birch and ash samples were the lowest rated. Opinions on how aesthetic the samples were viewed vary between the samples, and the only aspect found from the answers of open-ended questions that seemed to affect whether it was considered aesthetic was if the sample was seen as "natural". Reasons behind this might be partly from the preferences of Chinese market being influenced by darker colored hardwood, such as rosewood, being historically commonly used and having a status of a "noble wood" (China Today 2018). This showing in the questionnaire by pine wood samples being viewed as expensive more often than birch or ash.

Other important visual aspects of the optimal wood for the said market would be one with varying patterns and natural look, creating an image of pureness when viewing the wood. For surfaces meant for use, the ability to be easily cleaned has a positive effect on its desirability, but the use of too much lacquer or it having an artificial look, will affect negatively on wood samples desirability, and especially on how environmentally friendly it is viewed. The general view of wood being used in buildings was seeing them as "beautiful", "environmentally friendly" and "healthy" as well as giving a feeling of "softness" or connecting people with nature.

Respondents often acknowledged some of wood's special qualities when used in construction such as thermal insulation and the ability to endure seismic stress. The promotion of green and environmentally friendly lifestyle, development of wood industry and culture, China's history of wood usage along with people's search for a more comfortable lifestyle were given as the major driving forces for wooden construction.

As nature and natural materials are often considered healthy, or at least healthier than other materials, and as it was previously mentioned that wooden elements or décor often cause same reactions in humans as wood in nature, (Puuinfo 2014) it is no wonder that answers are mostly agreeing with the statement. The reasoning why all the samples were often seen as healthy, might be related to the old "five elements theory", which is still partly used in Chinese medicine. In this ancient theory everything is formed by five natural elements, one of them being wood which symbolizes benevolence or good will. Today it is only visible in traditional Chinese medicine and acupuncture, as it was thought that every single one of these elements has special healing powers to certain parts of human body, with wood as an element being eyes and liver for example. (Travel China Guide 2020.) Even though this theory is not exactly in prominent use today, it has had its effect in Chinese culture. Of course, there are also other slightly more scientifically backed reasons why wooden materials are considered healthy, such as the relaxing effect of seeing wooden surfaces, along with the effects to environmental health during the lifecycle of the wooden building to name a few. These reasons might be some of the main ones that have influence on the healthy image of wood. Comments describing sample as healthy were quite evenly given to all samples, but like with samples being viewed aesthetic, the more comments it got about being "natural", the better scoring it got on the healthiness question.

The given commends or critiques in the field of durability did not seem to affect the opinion whether the sample would like to be used in the respondents' own home. Whether the samples would have been liked to be used in respondents' own homes seemed to be directly connected with how liked the color was, with

other aspects not being as important. The answers on “I would like to see this kind of wood in hotels where I stay”, were following similar lines with the answers on the question “I would like to use this kind of wood in my own home” but the answers being less harsh, and the overall amount of agreeing answers were slightly higher while the amount of disagreeing answers were lower.

Also, it is worth adding that the samples in this study weren't heavily treated, and at most they were sanded and then either lacquered or oiled as it is common for wood products produced to be used on visible surfaces. The reasons, why the answers are not even more positive, might instead relate to the history of Chinese forest industry and their usage of wood. There have been times ranging from 1980's where logging has been banned or restricted in different provinces due to overuse of natural resources (Ramzy 2015), and in 2019 the logging of natural forest has been banned for the time being to protect and restore natural forests to the area of 200 million hectares by 2035 (Kwok 2019).

The most common faults given to the samples was them being either too bright or having too light of a color, these were given to ash and birch samples more often than pine wood ones, although all of the latter ones also received comments of that nature. Most often the given disadvantage of wooden construction was a concern or a doubt on the durability of the building. Especially concerns such as fire safety, waterproofness and pests were commonly pointed out. Among this, some structural disadvantages of wood made some respondents consider wood to be unsuitable, or at least a dubious material when constructing taller buildings. These factors were also pointed out to be some which slow down the spreading of wooden construction in China, while pointing out that the level of wooden construction needs to be improved, and supported by governmental policies for it to have a chance of becoming popular in more densely populated places around China, an answer that is similar to that which Qu & al (2012) mentioned on in their study as well. All of the samples were seen as climate-friendly, which was often also mentioned in the open-ended answers, unless the sample was considered to be too highly treated, then it caused some worrying whether the lacquer or oil

was environmentally safe. Much like the comments on environmental or eco-friendliness, the comments of samples seeming healthy were often given, although unlike with environmental friendliness, there were no comments suspecting samples on being unhealthy.

These answers are interesting in a way that most of these faulty aspects are actually very good in houses made of wood, and excluding the height limitations, they can be directly compared with concrete houses for example. Even in this work some of these worries such as fire safety have been discussed in chapter five, and with either wooden construction getting more common, or more vocal advertising of woods properties when used in construction, most of these prejudices regarding wood as a clearly inferior building material would become less common.

## **11.2 Potential Effects on Wood Products Export o China**

Looking at both the positive and negative factors given by the respondents, pine would be the optimum wood to be imported from Finland to the wood market of Shaanxi. And with the intention on it being used for visible surfaces, more accurately the heartwood of pine would probably be the best, due to it having a darker shade than the surrounding sapwood. There might also be a market for some of the brighter colored wood, but according to this study, it would be not as desired as the before mentioned. Pine would be an excellent choice for import from other aspects as well, due to it being the most common wood species in Finland and having good properties considering the durability aspects. To give examples, the heartwood of pine is moderately resistant to rot, and it can handle humidity moderately to name a few (Harju & Venäläinen 2020).

For the importing part itself, there already is a direct route between the Finnish city of Kouvola and the Chinese city of Xi'an that was established in 2017. Due to it being currently underused, some new traffic caused by importing wood would most likely be greatly welcomed. To improve both the wood market and relations between the two parties, importing the knowhow of Finnish forestry and wooden construction to China would also be beneficial.

When spreading the skills in wooden construction, as well as its benefits and using the sustainable forestry methods as a kind of a marketing tool, the popularity of wooden buildings would likely grow. Finland also being one of the forerunners in sustainable forestry, the cooperation between two countries regarding this aspect would be beneficial too, as it is one of the environmental aspects China has been recently starting to focus on. Therefore, similarly as Russia and Canada are doing forestry related trade in eastern China, Finland could try to expand to the wood market of Northwest China, starting from the province of Shaanxi, using both the importing of wooden products as well as forestry knowledge with means of cooperative projects regarding forestry, both on the corporate as well as on the educational level. The factors encouraging this would be the relatively low level of international forestry trade going on in the Northwest Chinese market, already formed direct railway route between Kouvola and Xi'an as well as previously held study period for the Chinese forestry students from Northwestern Agricultural university coordinated by Karelia University of Applied Sciences in cooperation with likes of University of Eastern Finland. This hopefully paves the way for other future cooperative projects between the two parties in the field of forestry education.

### **11.3 Ideas for Future Research**

As it was previously mentioned that wooden construction requires the support of government by the ways of social policies and promotion of green building to advance in China. It should also be pointed out that during the couple previous years this has already slowly started. With some concrete policies considering the promotion of wooden buildings implemented last year in the autumn of 2019 (Xu 2019), the information regarding the benefits of wood as a building material could rise to more general knowledge. Studying the effects of these policies, how and where they are being currently implemented and how they will affect the wood market of China should be studied. As these kinds of policies usually come with strict set of standards in China, this could be considered both from the view of Finnish forestry companies, and local Chinese communities, especially in the more rural areas to provide them valuable information about what sort of wood could see a growth in demand in the Chinese market. Among similar lines with

this one, the possibilities of cooperative projects in the field of forestry such as the one between NWFU and Karelia University of Applied Sciences (Laukkanen 2019), and their positive effects on forestry and other fields could also be an interesting subject for a study. Like the idea for a study about environmental policies of China, this one could also be one that takes some time to show real changes, but the results could be interesting. As especially with cultivation of knowledge in the field of sustainability in forestry, the effects could be very valuable for further cooperation.

With the Kouvola – Xi'an railway route already having been established in 2017, it could be studied why this has not been used more than it already is. Or more specifically, why the amounts of imports sent to both ways have been in decline almost right after its opening. The findings could then be used to improve the current system and to avoid making again the same mistakes from the past. This railway being of extreme importance for the importing of products from Finland to Northwest China, studying and potentially improving this part of the logistics route would be key for the success of getting into this market area. Some potential problems of importing certain types of wood products, especially timber, for such a long way could also be studied with this. Then, with these findings it could be seen if the practical aspects of the importing process can be made work and jointed with studies like this one and others of similar nature, could provide a more complete view of the process.

Similarly, studies like this one could be done in different areas of China, focusing them on certain provinces or at largest on different regions to find out if there are areas that are even better suited market areas for Finnish wood products or forestry services. Due to the size and cultural differences between areas of China, it is not smart to use the results of this study to figure out what sort of wood would be popular in South Central China for example. Certainly, some similarities will be found, but more accurate and reliable results will be received when this sort of survey is being ran in the exact area where the information received from the data will also be used.

## References

- American Wood Council. 2019. Designing for Earthquakes. Think Wood. Engineering News-Record.  
[https://1r4scx402tmr26fqa93wk6an-wpengine.netdna-ssl.com/wp-content/uploads/2019/12/Think-Wood-CEU-Designing-for-Earthquakes\\_Dec2019.pdf](https://1r4scx402tmr26fqa93wk6an-wpengine.netdna-ssl.com/wp-content/uploads/2019/12/Think-Wood-CEU-Designing-for-Earthquakes_Dec2019.pdf)
- Belt & Road Forum. 2019. 19 Mar 2020  
<http://www.beltandroadforum2019.com/conference-profile/overview/>
- Brännare, S. 2019. Kiinan selluvarastot alkavat olla täynnä ja hintakin on laskenut – metsäjätit porskuttavat, mutta Kiinassa piilee myös riskejä. Yle. 5 Apr 2020  
<https://yle.fi/uutiset/3-10591616>
- Cartwright, M. 2017. Chinese lacquerware. Ancient history encyclopedia. 12 Apr 2020  
<https://www.ancient.eu/article/1090/chinese-lacquerware/>
- Chen, Q. 2013. Analysis of the wood frame construction market in China. 28 Mar 2020
- China Today. 2018. Chinese Classical Furniture: Antique and Ingenious. 12 Apr 2020  
[http://www.chinatoday.com.cn/ctenglish/2018/cs/201807/t20180710\\_800134905.html](http://www.chinatoday.com.cn/ctenglish/2018/cs/201807/t20180710_800134905.html)
- Davies, P. & Liu, Z. 2020. Environmental and Social Policy in China: What will 2020 hold? Latham & Watkins. 5 Apr 2020  
<https://www.globalelr.com/2020/01/environmental-and-social-policy-in-china-what-will-2020-hold/>
- Edwards, P. & Perilli, D. 2019. Cement in China. Global Cement Magazine. 5 Apr 2020  
<https://www.globalcement.com/magazine/articles/1126-cement-in-china>
- Elbein, S. 2020. Will the skyscrapers of the future will be made out of wood. National Geographic. 2 Apr 2020  
<https://www.nationalgeographic.com/science/2020/01/skyscrapers-of-the-future-will-be-made-out-of-wood/>
- European wood in China. Energy efficiency of wood buildings. 28 Mar 2020  
<https://www.europeanwood.org.cn/en/energy-efficiency>
- Fell, D.R. 2010. Wood in the human environment: restorative properties of wood built in indoor environment. University of British Columbia. 8 Apr 2020
- Finnish Forest Industries. 2015. The Finnish forest industry in figures. Finnish Forest Industries. 17 Mar 2020  
<https://web.archive.org/web/20160812192653/http://forestindustries.fi/statistics/The-Finnish-forest-industry-in-figures-1274.html>
- Glaeser, E. & Huang, W. & Ma, Y. & Schleifer, A. 2016. A real estate boom with Chinese Characteristics. National Bureau of Economic Research. 5 Apr 2020
- Hao, F. 2018. China releases 2020 action plan for air pollution. China dialogue. 5 Apr 2020  
<https://www.chinadialogue.net/article/show/single/en/10711-China-releases-2-2-action-plan-for-air-pollution>
- Harju, A. & Venäläinen, M. 2020. Suomen metsissä lymyää unohdettu aarre: männyn sydänpuu. Luonnonvarakeskus.  
<https://www.luke.fi/blogi/suomen-metsissa-lymyaa-unohdettu-aaarre-mannyn-sydanpuu/>
- Jamieson, S. 2020. Likert Scale. Encyclopedia Britannica. 26 Apr 2020  
<https://www.britannica.com/topic/Likert-Scale>

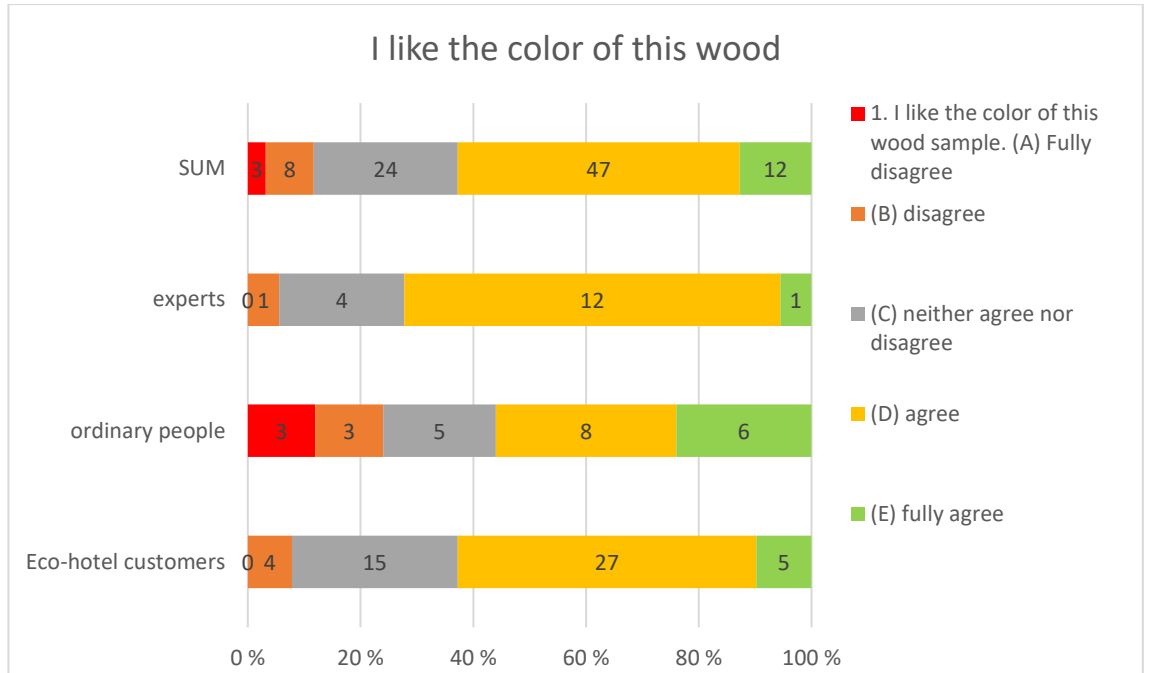
- Kaihlainen, J. 2019a. Puun tuontimäärä kasvoi kolmanneksen viime vuonna – ulkomailta puuta ostettiin Suomeen puolen miljardin euron arvosta. Maaseudun Tulevaisuus. 2 Apr 2020  
<https://www.maaseuduntulevaisuus.fi/metsa/artikkeli-1.520724>
- Kaihlainen, J. 2019b. Sahatavaran vienti Suomesta Kiinaan väheni yhä alkuvuonna. Maaseudun tulevaisuus. 5 Apr 2020  
<https://www.maaseuduntulevaisuus.fi/metsa/artikkeli-1.424572>
- Karelia University of Applied Sciences. 2020. Joensuu Light House – Tutkimus- ja kehitystoimenpiteet. 26 Apr 2020  
<https://www.karelia.fi/puurakentaminen/tutkimus/joensuu-light-house-tutkimus-ja-kehitystoimenpiteet/>
- Karjalainen, M. 2020. Puurakentamisen asema ja mahdollisuudet Suomessa. Puuinfo. 16 Mar 2020  
<https://www.puuinfo.fi/puutieto/puurakentaminen/puurakentamisen-asema-ja-mahdollisuudet-suomessa>
- Knox, A. & Parry-Husbands, H. 2018. Workplaces: Wellness + Wood = Productivity. Forest & Wood Products Australia. Pollinate. 8 Apr 2020  
<https://makeitwood.org/documents/doc-1624-pollinate-health-report---february-2018.pdf>
- Kuittinen, M. & Werner, F. Carbon storage. Metsäwood. Metsägroup. 2 Apr 2020  
<https://www.metsawood.com/global/news-media/articles/Pages/carbon-storage.aspx>
- Kwok, C. 2019. China to protect natural forests with new strict measures. South China Morning Post. 9 Apr 2020  
<https://www.scmp.com/video/china/3023854/china-protect-natural-forests-new-strict-measures>
- Laukkanen, M. 2014. The use of wood in hospital construction supports convalescence. Woodproducts.fi. 8 Apr 2020  
<https://www.woodproducts.fi/articles/use-wood-hospital-construction-supports-convalescence-0>
- Laukkanen, M. 2019. Professori Paavo Pelkonen: Suomalaisesta metsäosaamisesta koulutuksen vientituote. STT. 16 Mar 2020  
<https://www.sttinfo.fi/tiedote/professori-paavo-pelkonen-suomalaisesta-metsaosaamisesta-koulutuksen-vientituote?publisherId=4627873&releaseId=69872042>
- Leuschel, K. 2019. The rise and rise of timber. UPM. 2 Apr 2020  
<https://www.upmtimber.com/whats-new/2019/09/the-rise-and-rise-of-timber/>
- Li, C. 2019. Belt and Road: Shape a Brighter Shared Future. Helsinki Times. 19 Mar 2020  
<https://www.helsinkitimes.fi/world-int/16376-belt-and-road-shape-a-brighter-shared-future.html>
- Luonnonvarakeskus. 2020. Metla-house. 27 Apr 2020  
<https://www.luke.fi/en/natural-resources/attractions/metla-house/>
- Mahasen, N. & Smith, S. & Humphreys, K. 2003. The Cement Industry and Global Climate Change: Current and Potential Future Cement Industry CO2 Emissions. Proceedings of the 6<sup>th</sup> International Conference on Greenhouse Gas Control Technologies 1 – 4 October 2002, Kyoto, Japan. 2 Apr 2020
- Moore, R. 2018. Why wood is back at the top of the tree for architects. The Guardian. 20.4.2020.  
<https://www.theguardian.com/artanddesign/2018/jan/28/wood-engineered-timber-housing-needs>



- MOTV - Menetelmäopetuksen tietovaranto. 1 Apr 2020  
<https://www.fsd.tuni.fi/menetelmaopetus/index.html>
- Olivier, J. & Janssens-Maenhout, G. & Muntean, M. & Peters, J. 2016. Trends in Global CO2 Emissions – 2016 Report. PBL Netherlands Environmental Assessment Agency. 64-65. 16 Mar 2020.
- Pasanen, P. & Korteniemi, J. & Sipari, A. 2011. Passiivitasen asuinkerroksen elinkaaren hiilijalanjälki. Sitra. 2 Apr 2020  
<https://www.sitra.fi/julkaisut/passiivitasen-asuinkerrostalon-elinkaaren-hiilijalanjalki/>
- Puuinfo. 2014. Wood construction reduces stress and offers a healthy living environment. 8 Apr 2020  
<https://www.woodproducts.fi/articles/wood-construction-reduces-stress-and-offers-a-healthy-living-environment>
- Puurakennus on hiilinielu. UPM. 2 Apr 2020  
<https://www.metsagroup.com/fi/Media/Pages/Case-Puurakennus-on-hiilinielu.aspx>
- Qu, M. & Pelkonen, P. & Tahvanainen, L. & Arevalo, J. & Gritten, D. 2012. Expert's assessment on the development of wood framed houses in China. Journal of Cleaner Production. 27 Mar 2020
- Que, Z. & Li, Z. & Zhang, X. & Yuan, Z. & Pan, B. 2016. Traditional Wooden Buildings in China. 28 Mar 2020  
<https://www.intechopen.com/books/wood-in-civil-engineering/traditional-wooden-buildings-in-china>
- Ramzy, A. 2015. China issues new guidelines to reduce logging. The New York Times. 9 Apr 2020  
<https://sinosphere.blogs.nytimes.com/2015/03/19/china-issues-new-guidelines-to-reduce-logging/>
- Research and Markets. 2019. PR Newswire. 30 Mar 2020  
<https://www.prnewswire.com/news-releases/china-timber-import-report-2019-300780873.html>
- Roivainen, M. 2015. Kuuden hengen potilashuoneet ovat historiaa – Uuteen sairaalaan on tulossa yhden hengen huoneita. Yle. 8 Apr 2020  
<https://yle.fi/uutiset/3-8258351>
- Seto, K. 2013. What should we understand about urbanization of China. Yale Insights. 5 Apr 2020  
<https://insights.som.yale.edu/insights/what-should-we-understand-about-urbanization-in-china>
- Siikanen, U. 2008. Puurakentaminen. Esa Print Oy. Tampere. 164-166
- Skön, K. 2019. Kouvolasta rakennettiin suora junayhteys Kiinaan – Kiinan valtio maksoi niin paljon tukea, että raiteilla kannatti kuljettaa liki tyhjiä kontteja. YLE. 19 Mar 2020  
<https://yle.fi/aihe/artikkeli/2019/12/02/kouvolasta-rakennettiin-suora-junayhteys-kiinaan-kiinan-valtio-maksoi-niin>
- Tannert, T. & Follesa, M. & Fragiaco, M. & Gonzalez, P. & Isoda, H. & Moroder, D. & Xiong, H. & van de Lindt, J. 2018. Seismic design of cross-laminated timber buildings. Wood and fiber science.
- Travel China Guide. The Five Elements. 13 Apr 2020  
<https://www.travelchinaguide.com/intro/astrology/five-elements.htm>
- The World Bank. The World Bank in China. 5 Apr 2020  
<https://www.worldbank.org/en/country/china>
- Treanor, N.B. 2015. China's Hongmu Consumption Boom. Forest Trends. 12 Apr 2020

- University of Oulu. 2020. Uraauurtavaa puukoulun terveystuikutusten tutkimusta Kuhmon Tuupalan alakoulussa. 8 Apr 2020  
<https://www.oulu.fi/yliopisto/uutiset/uraauurtavaa-puukoulun-terveysvaikutusten-tutkimusta-kuhmossa>
- Wang, H. 2019. China's Policies update. Canada Wood Today, September 2019 Newsletter. 16 Mar 2020  
<https://canadawood.org/chinas-policies-update/>
- Which building material performs better in a fire – wood or steel? NZ Wood. 4 Apr 2020  
<http://www.nzwood.co.nz/faqs/which-building-material-performs-better-in-a-fire-wood-or-steel/>
- Wood Joensuu. 2020. 27 Apr 2020  
<https://woodjoensuu.fi/wood-in-the-city/>
- Wood Joensuu. 2020. Wood in the city. 27 Apr 2020  
<https://woodjoensuu.fi/wood-in-the-city/>
- Wood resources international LLC. 2019. Canadian and Russian pulp, log exports to China increase amid U.S. trade tensions. Pulp & Paper Canada. 28 Mar 2020  
<https://www.pulpandpapercanada.com/canadian-and-russian-pulp-log-exports-to-china-increase-amid-us-trade-tensions-1100001785/>
- Woodarchitecture.fi. 2019. Light House Joensuu. 12 Apr 2020  
<https://www.woodarchitecture.fi/fi/projects/lighthouse-joensuu>
- Xu, W. 2019. China's march on Zero Energy Buildings. Canada Wood Today. 5 Apr 2020  
<https://canadawood.org/chinas-march-on-zero-energy-buildings/>

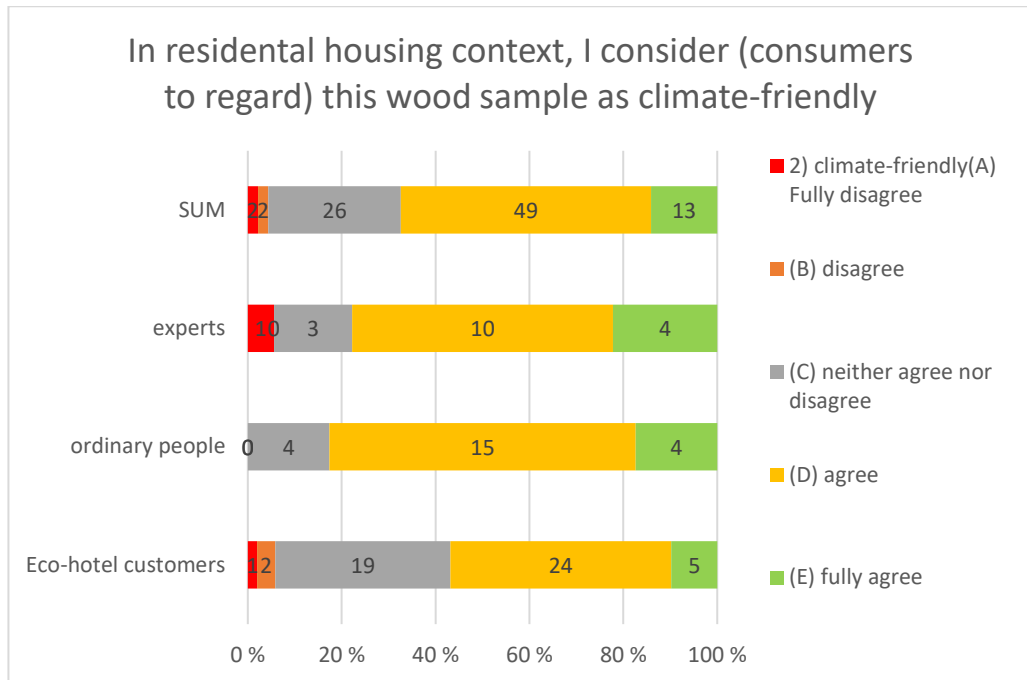
1. Sample A2 - pine natural ceiling/wall panel lacquer



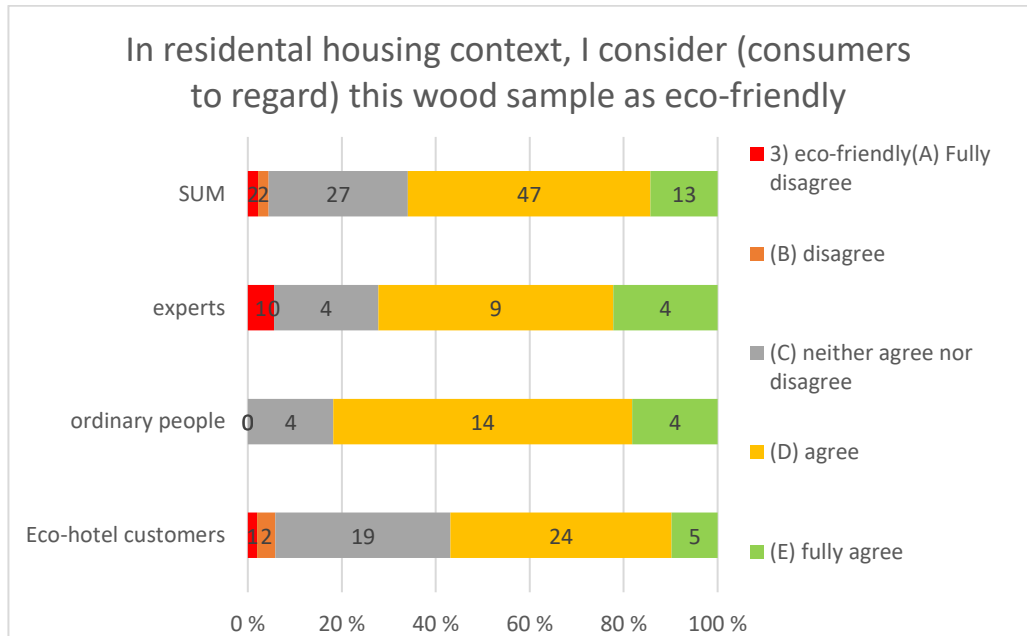
2. Sample A2 - pine natural ceiling/wall panel lacquer



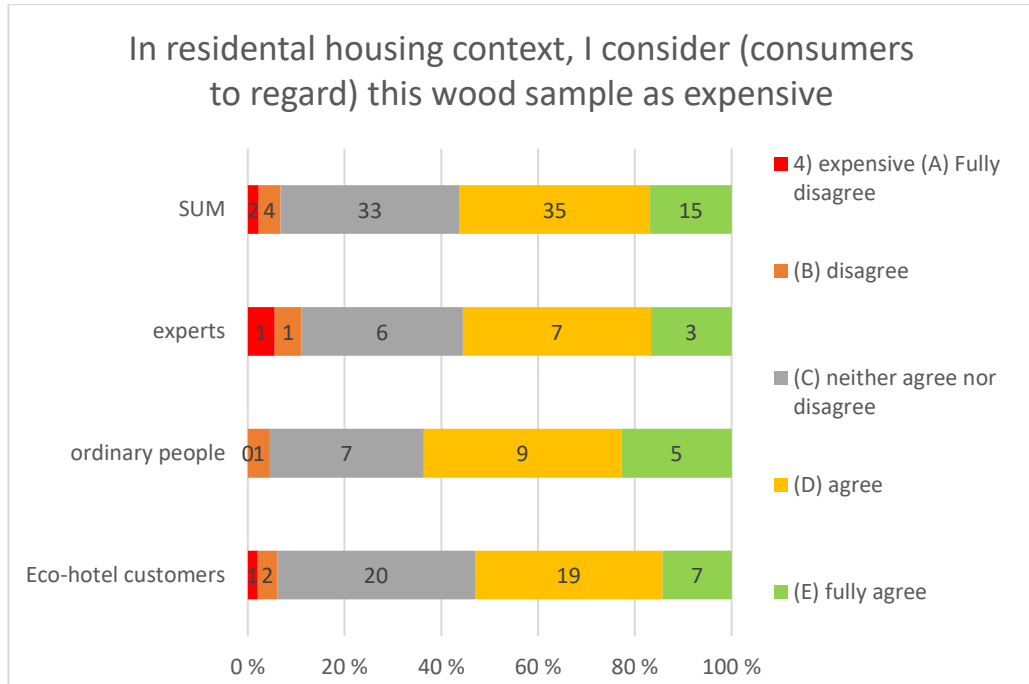
3. Sample A2 - pine natural ceiling/wall panel lacquer



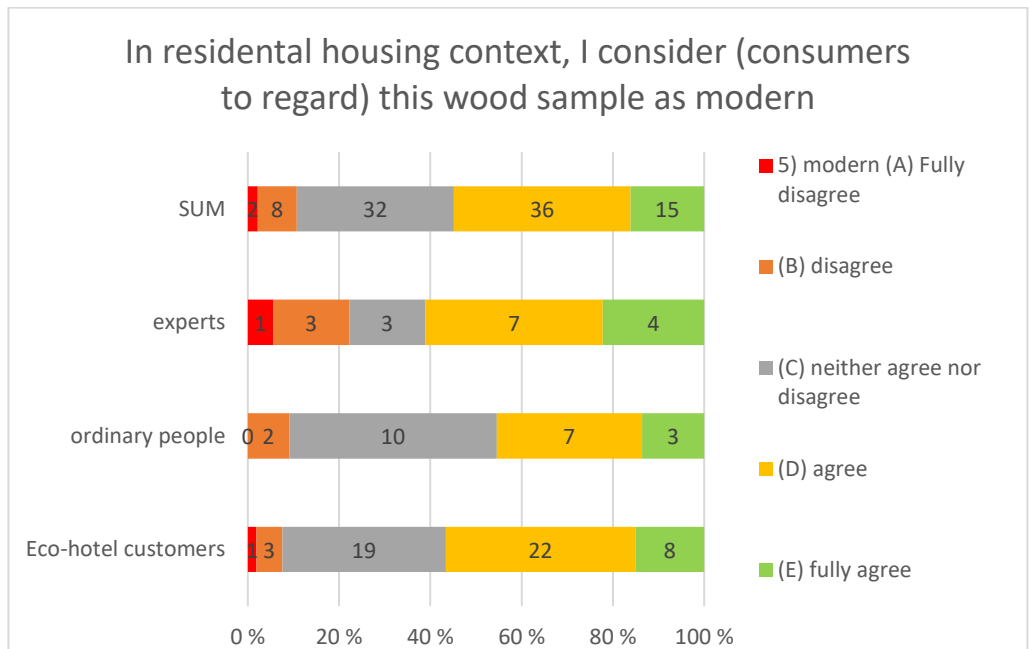
4. Sample A2 - pine natural ceiling/wall panel lacquer



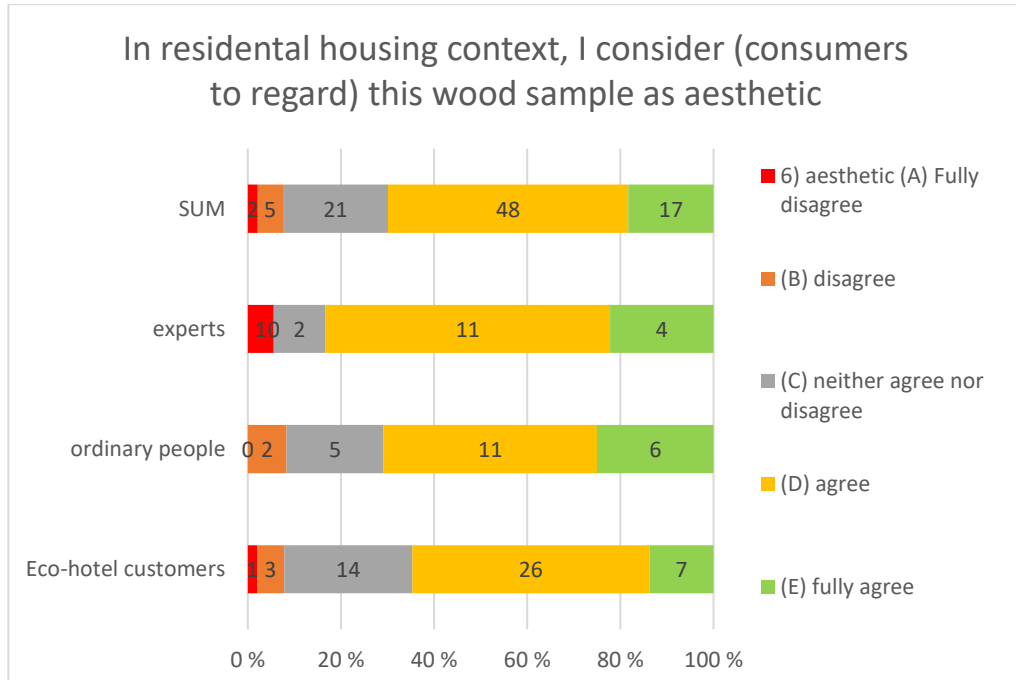
5. Sample A2 - pine natural ceiling/wall panel lacquer



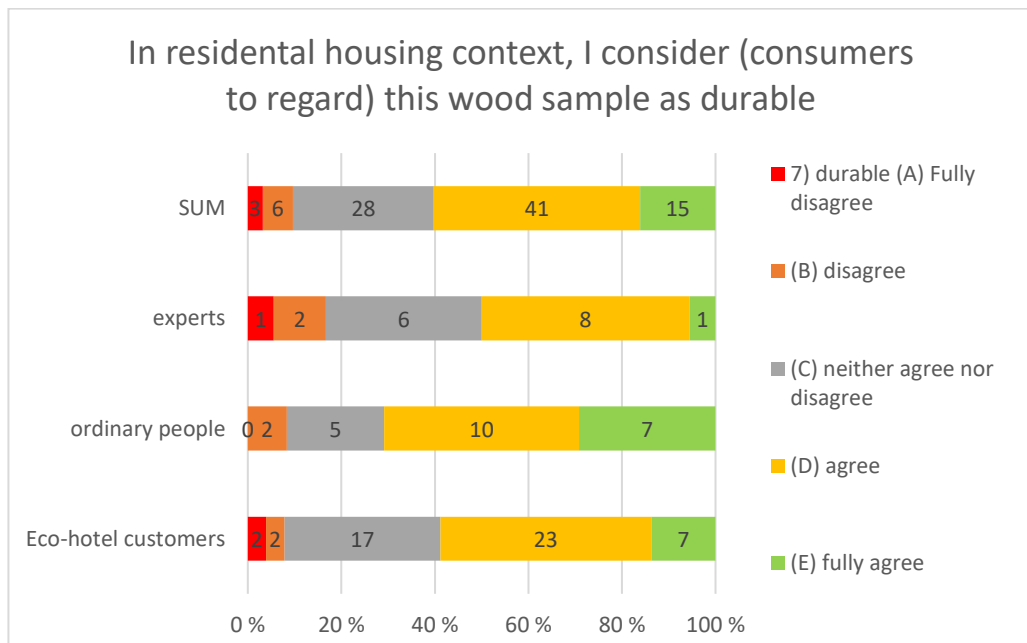
6. Sample A2 – pine natural ceiling/wall panel lacquer



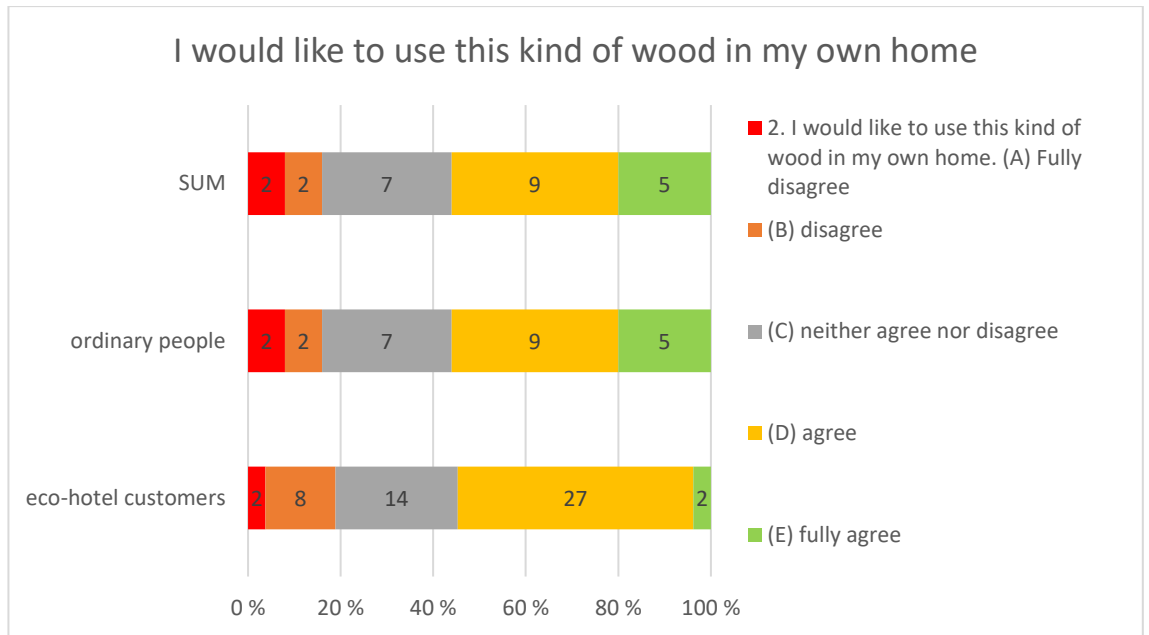
7. Sample A2 – pine natural ceiling/wall panel lacquer



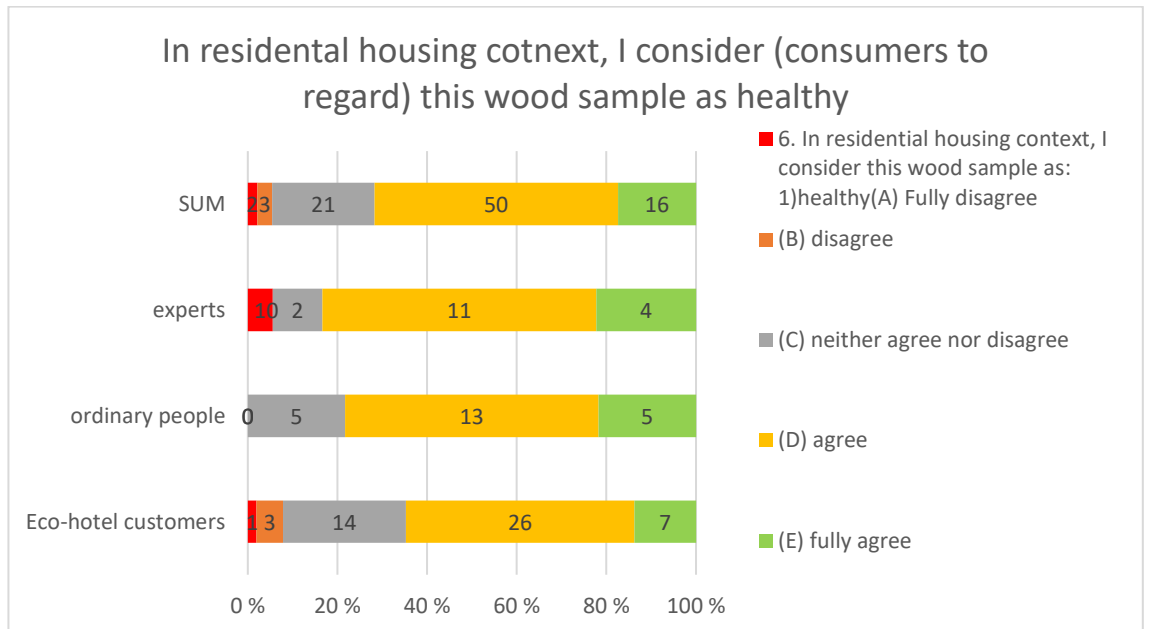
8. Sample A2 - pine natural ceiling/wall panel lacquer



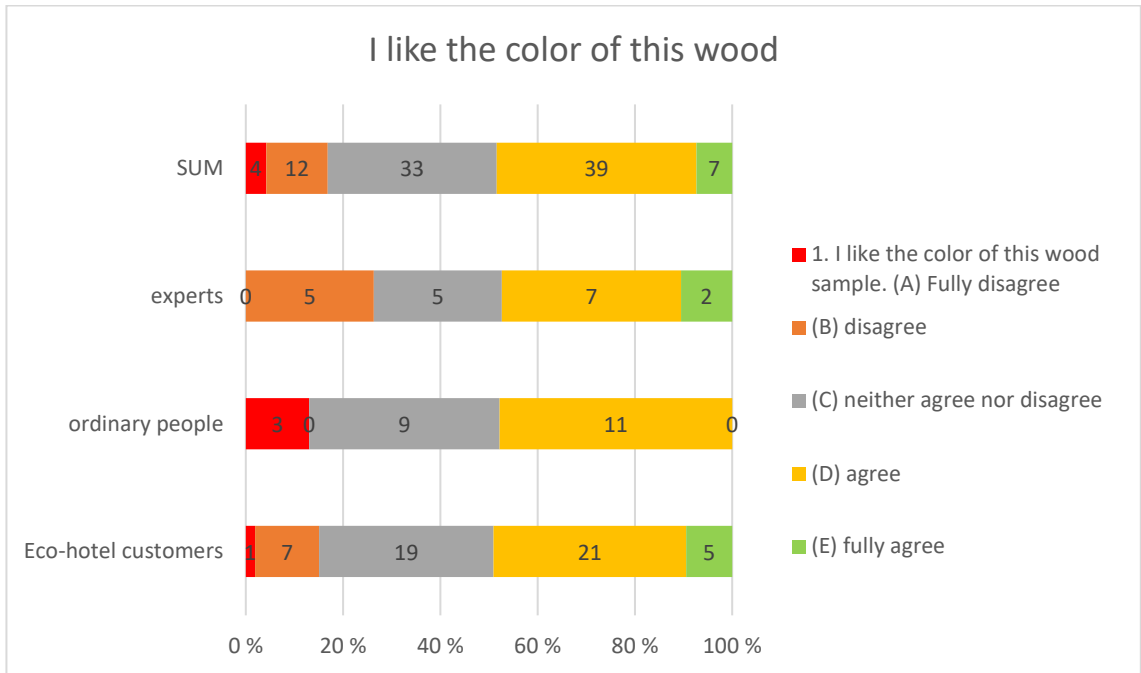
9. Sample A2 - pine natural ceiling/wall panel lacquer



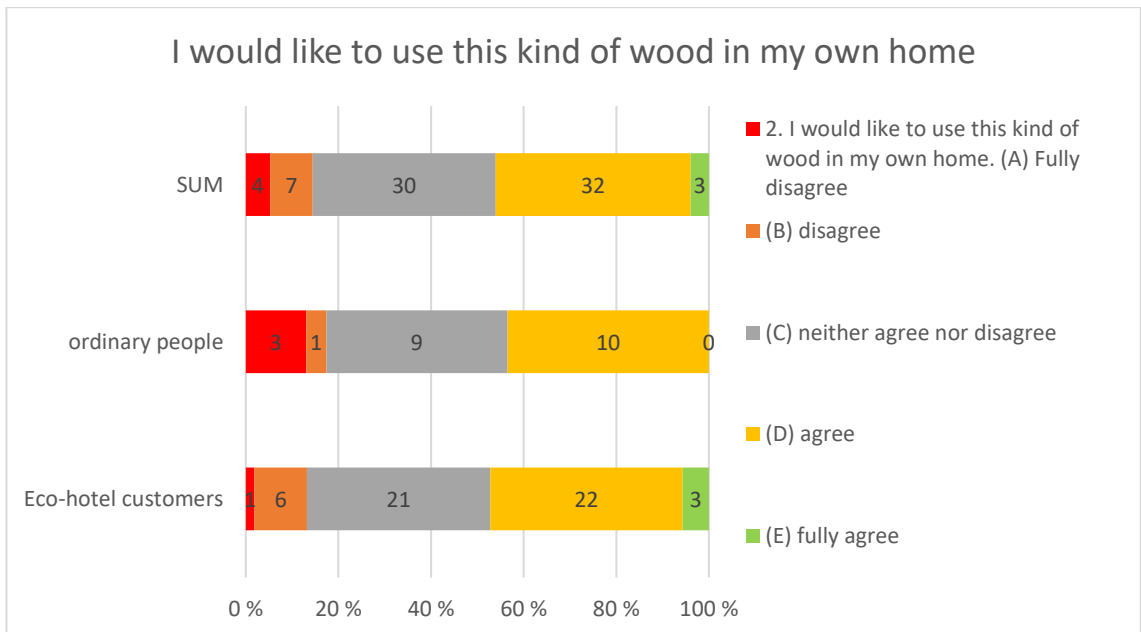
10. Sample A2 - pine natural ceiling/wall panel lacquer



1. Sample A4 – pine floor trim transparent white lacquer

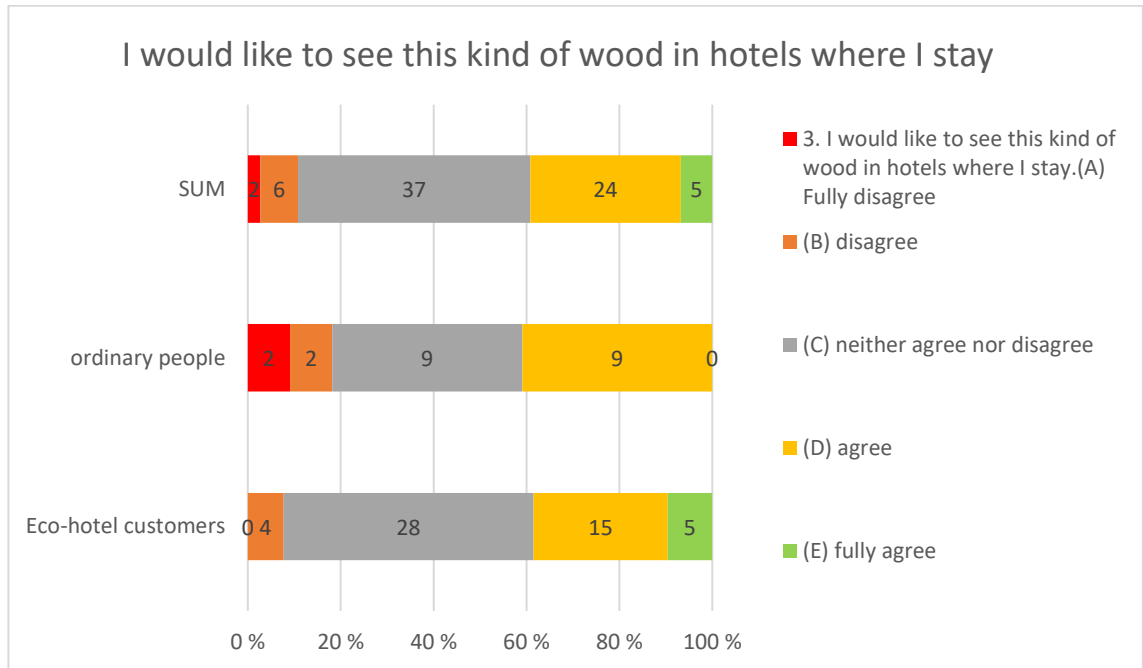


2. Sample A4 – pine floor trim transparent white lacquer

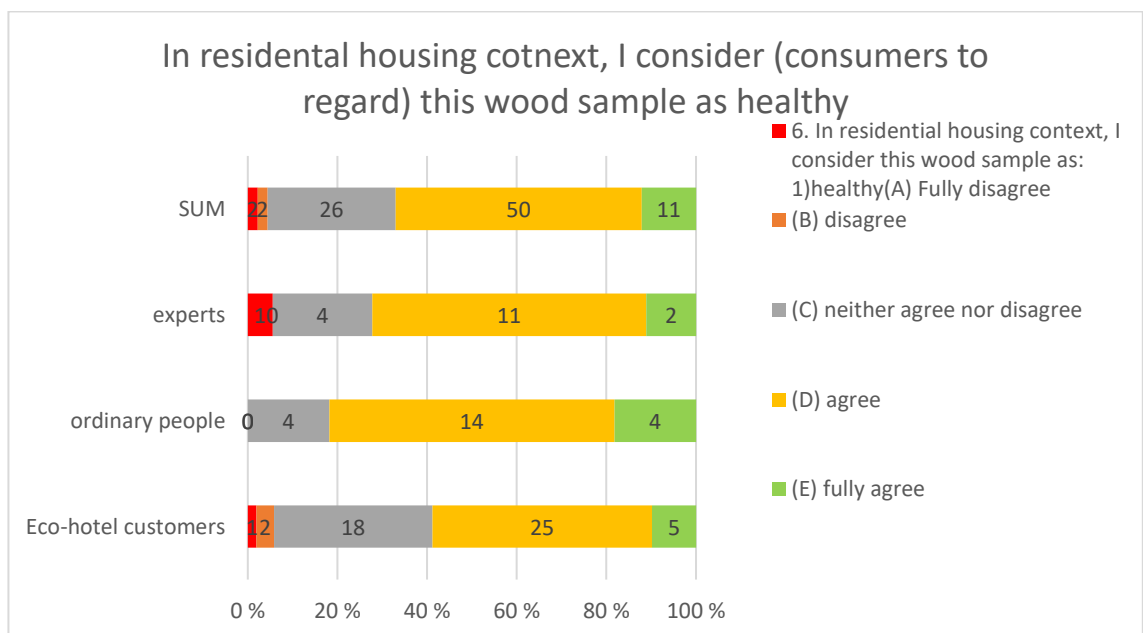




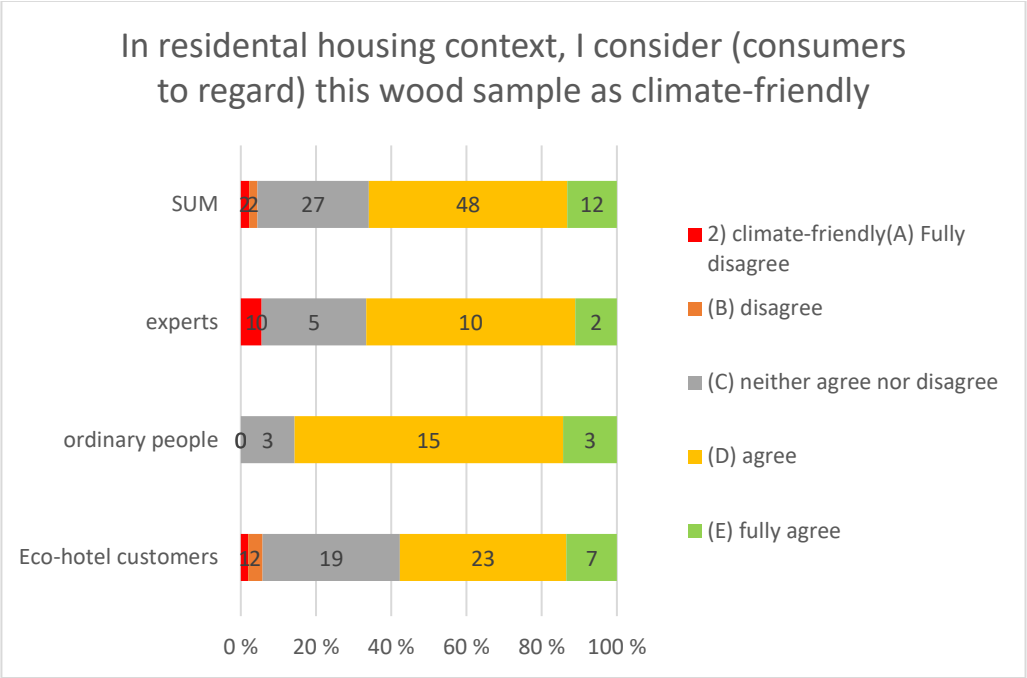
### 3. Sample A4 – pine floor trim transparent white lacquer



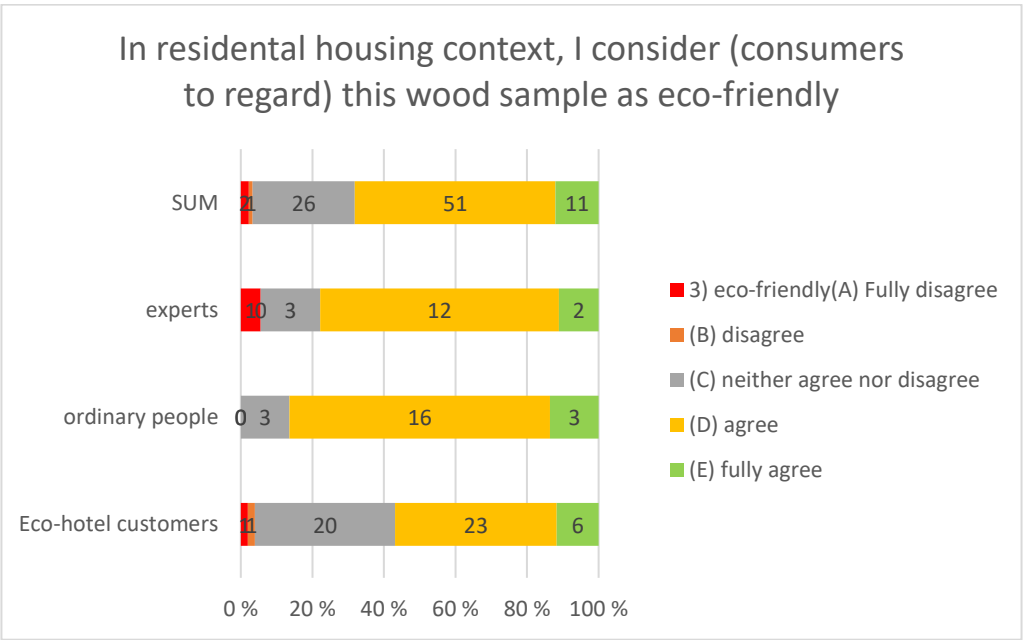
### 4. Sample A4 – pine floor trim transparent white lacquer



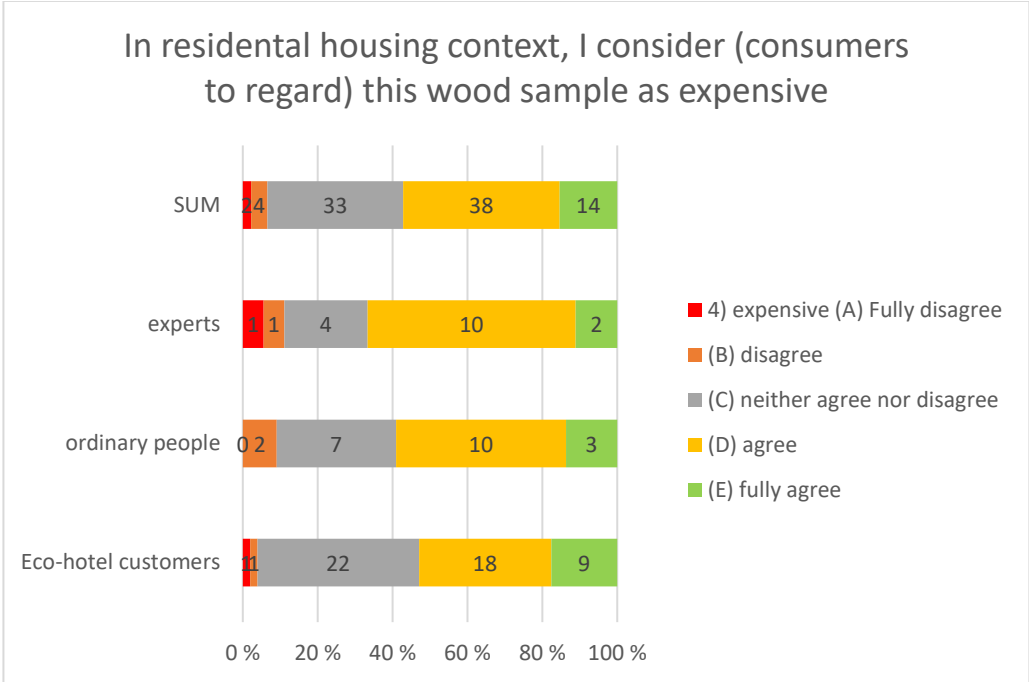
5. Sample A4 – pine floor trim transparent white lacquer



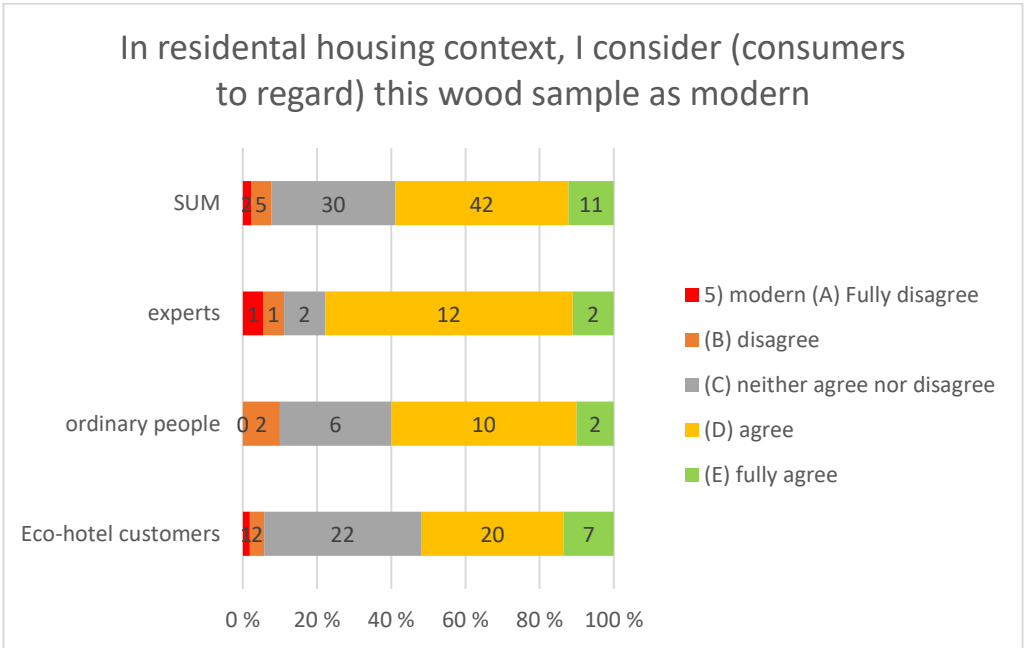
6. Sample A4 – pine floor trim transparent white lacquer



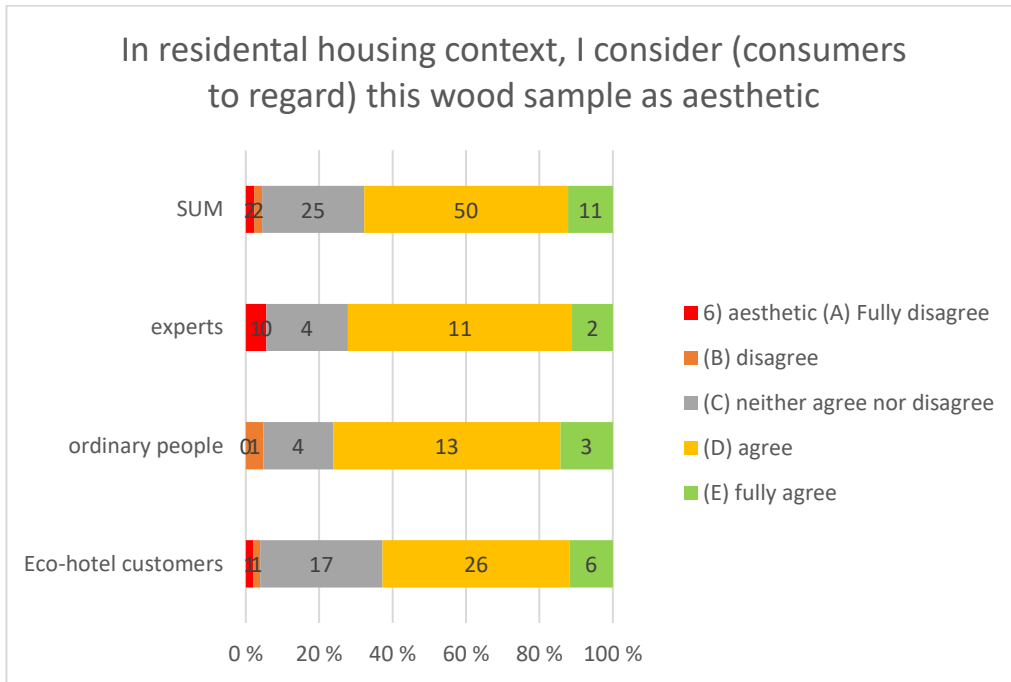
7. Sample A4 – pine floor trim transparent white lacquer



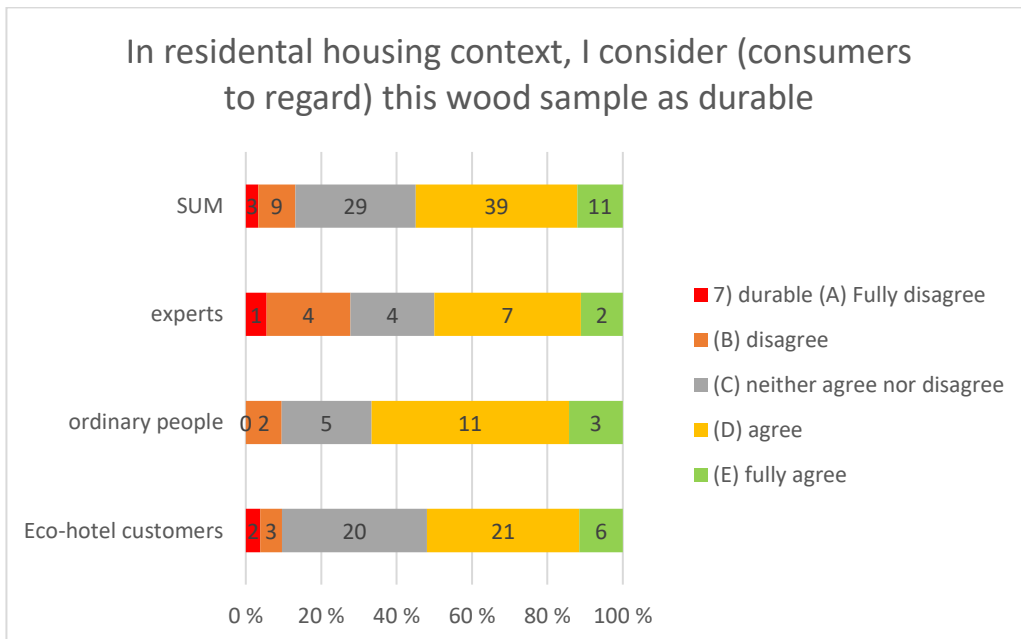
8. Sample A4 – pine floor trim transparent white lacquer



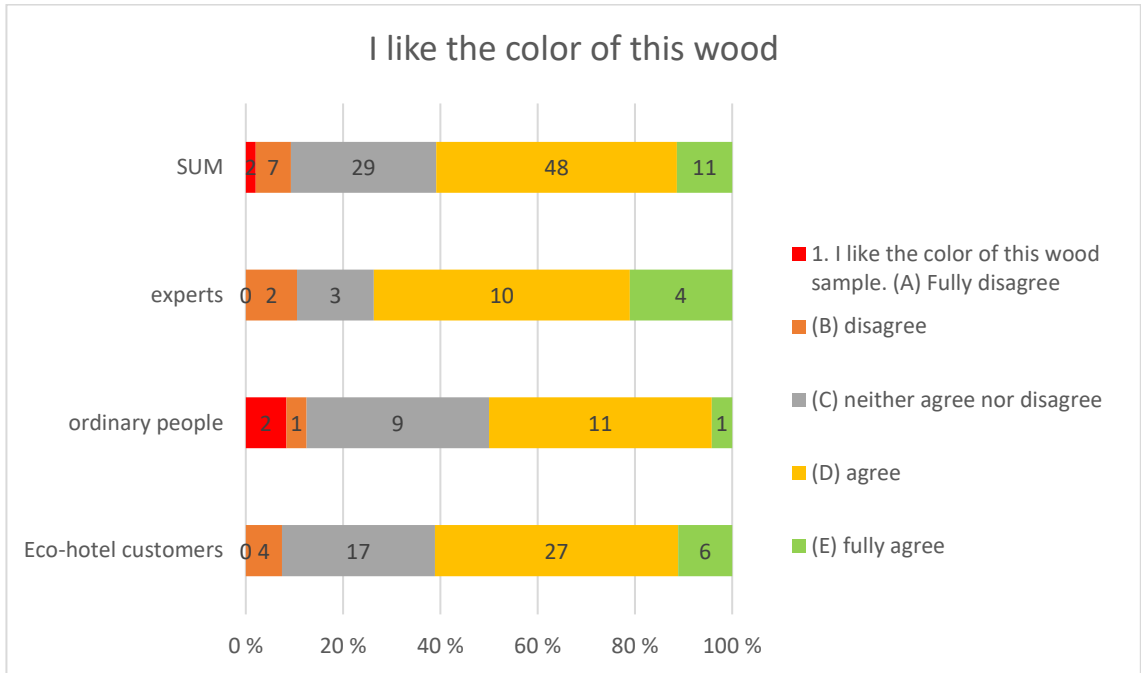
9. Sample A4 – pine floor trim transparent white lacquer



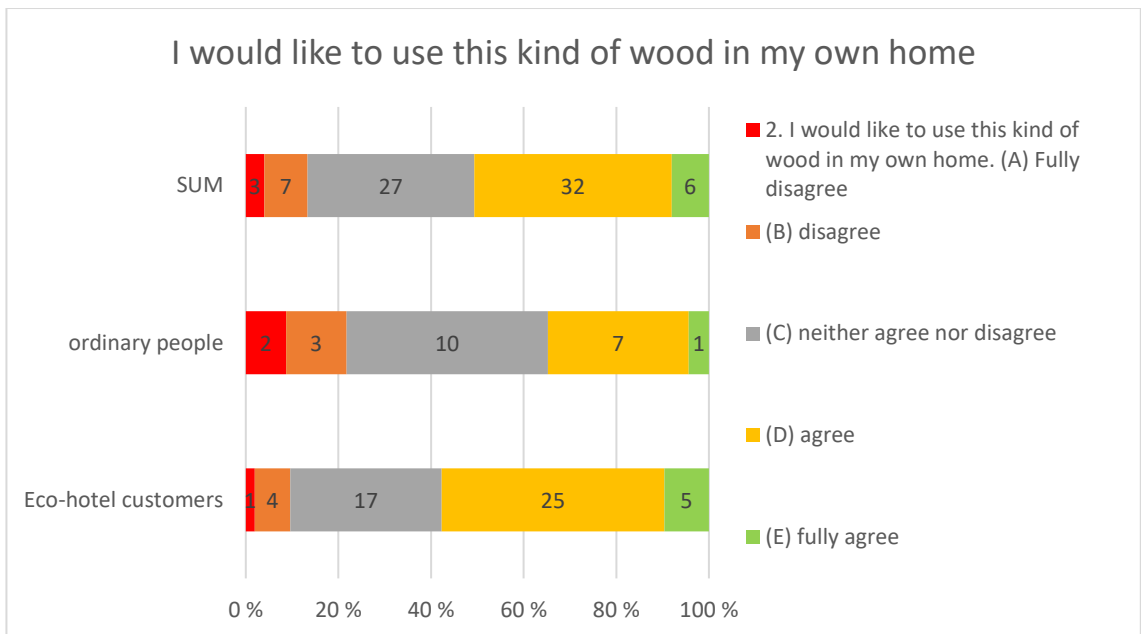
10. Sample A4 – pine floor trim transparent white lacquer



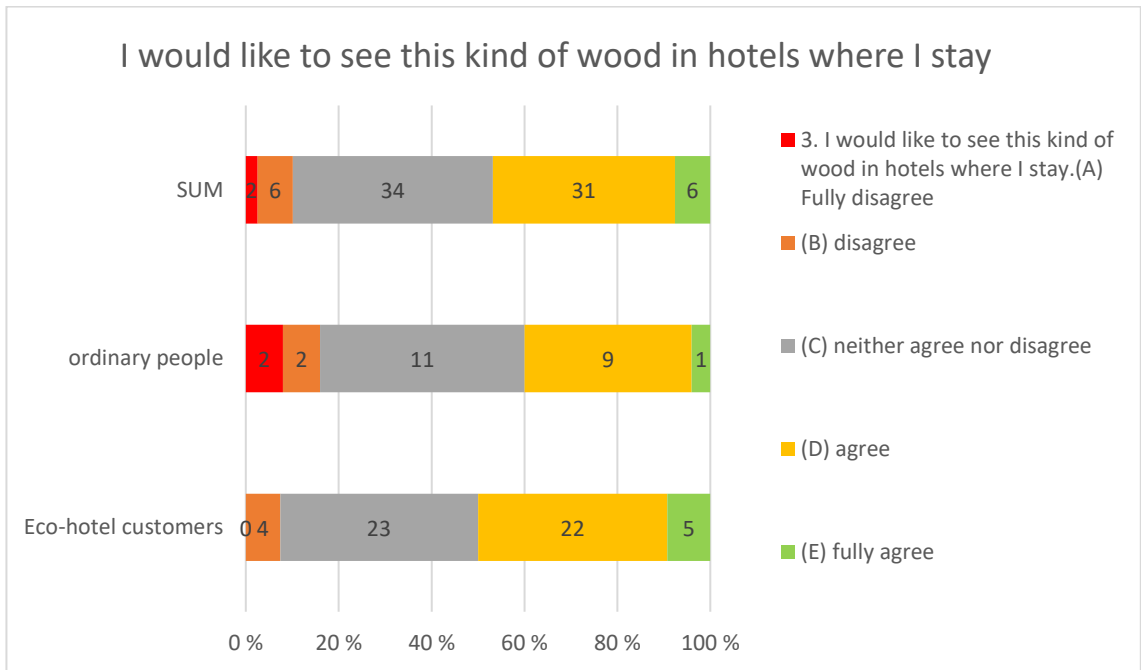
1. Sample A5 – pine wall panel, wall décor, round trim



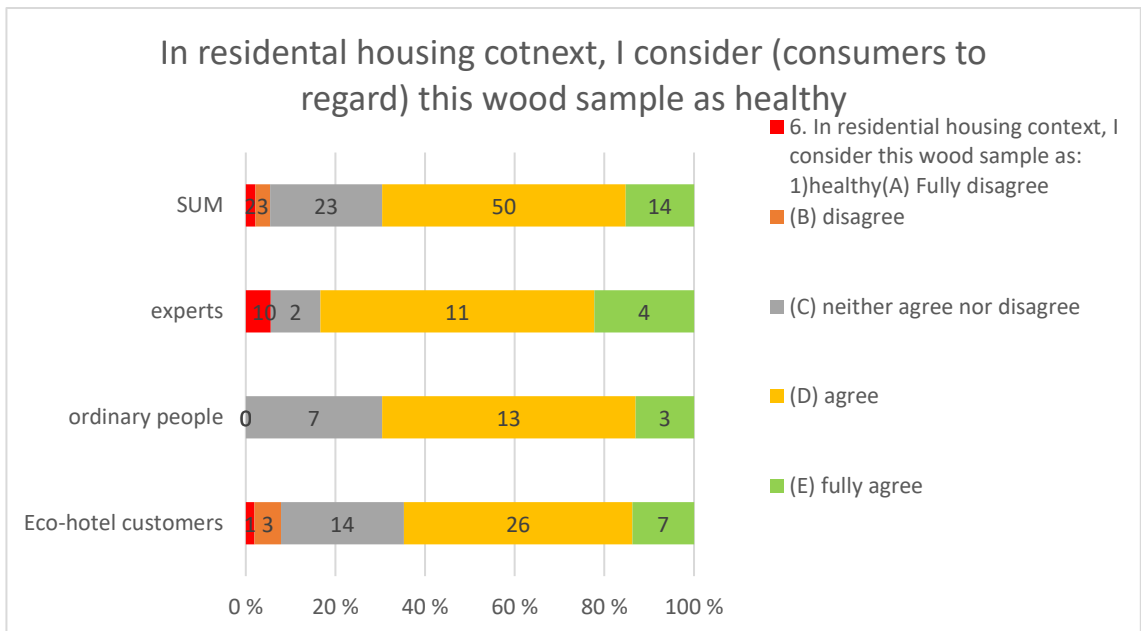
2. Sample A5 – pine wall panel, wall décor, round trim



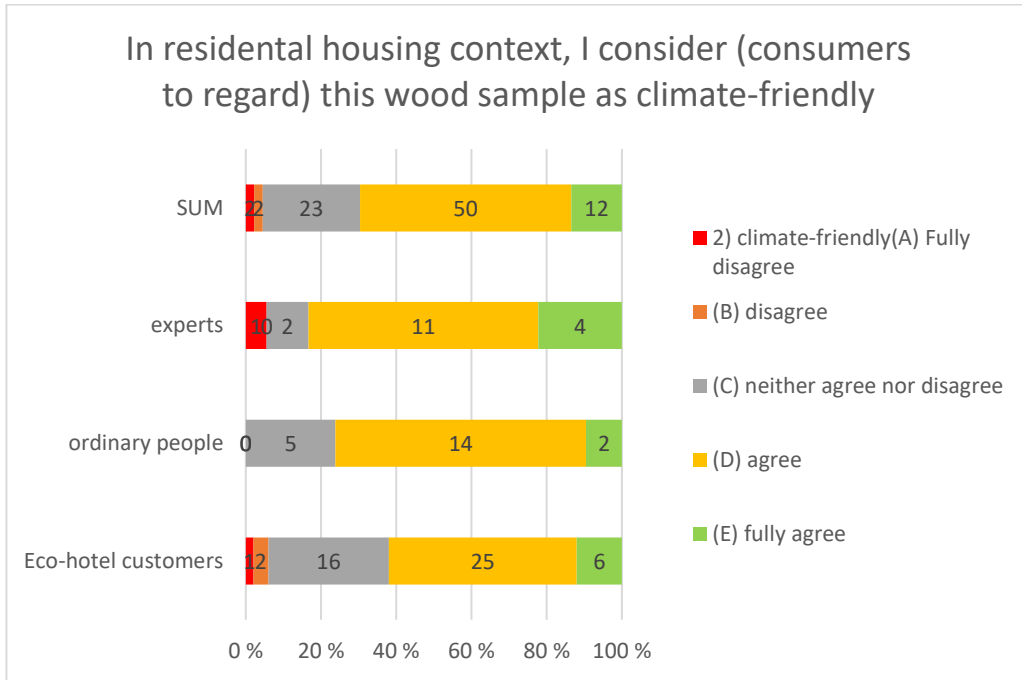
3. Sample A5 – pine wall panel, wall décor, round trim



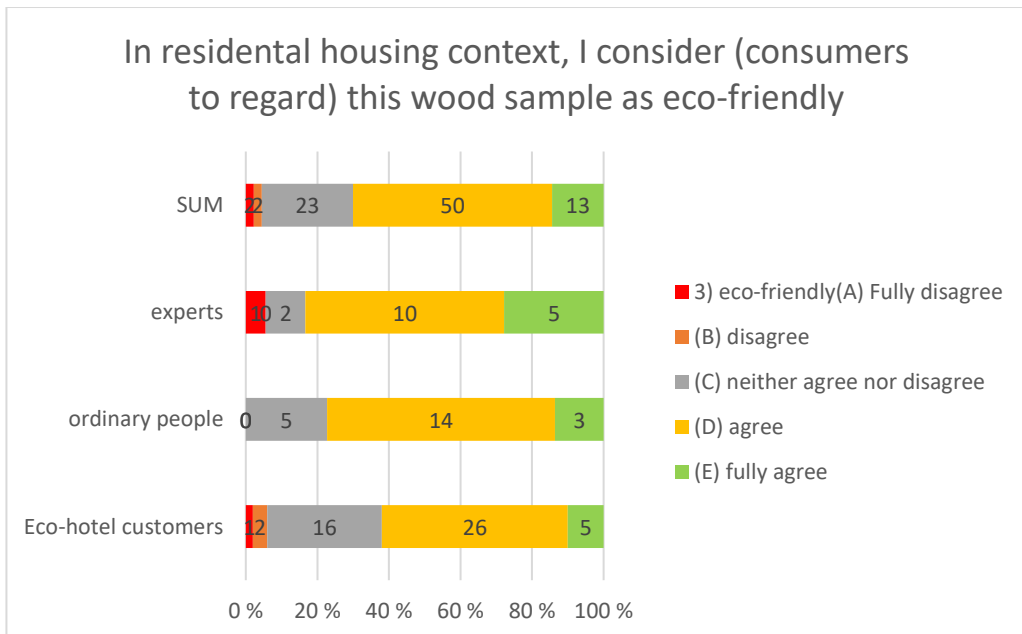
4. Sample A5 – pine wall panel, wall décor, round trim



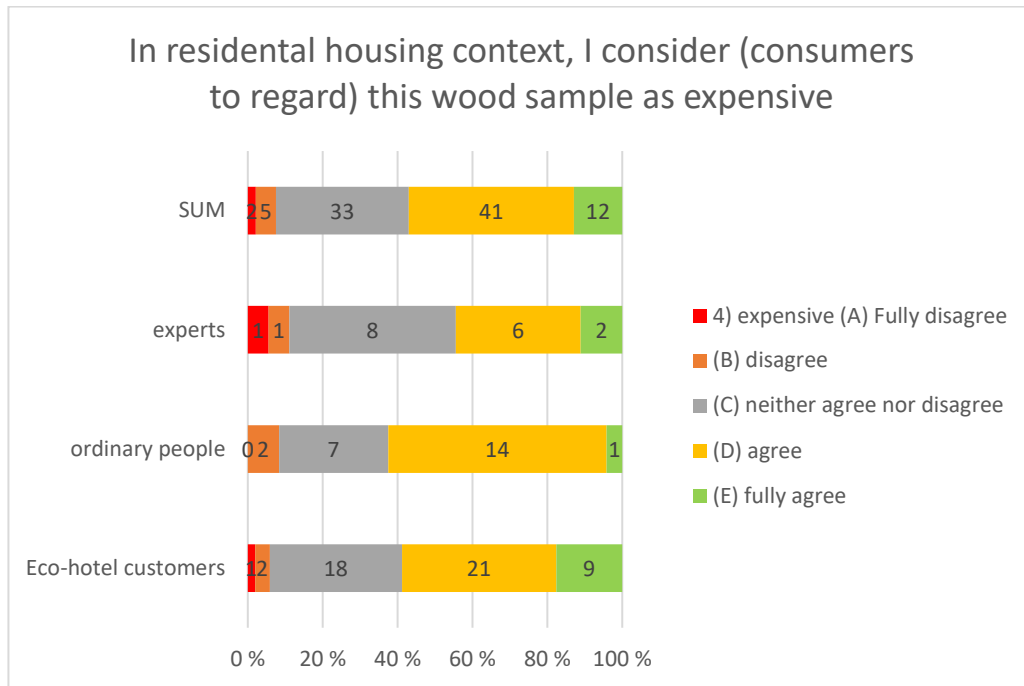
5. Sample A5 – pine wall panel, wall décor, round trim



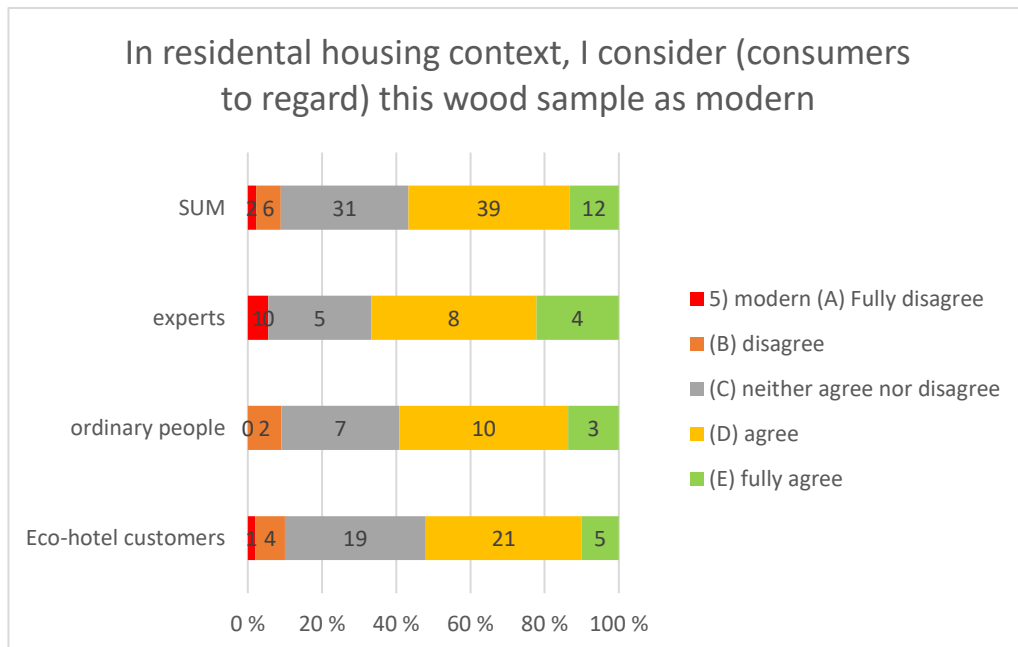
6. Sample A5 – pine wall panel, wall décor, round trim



7. Sample A5 – pine wall panel, wall décor, round trim

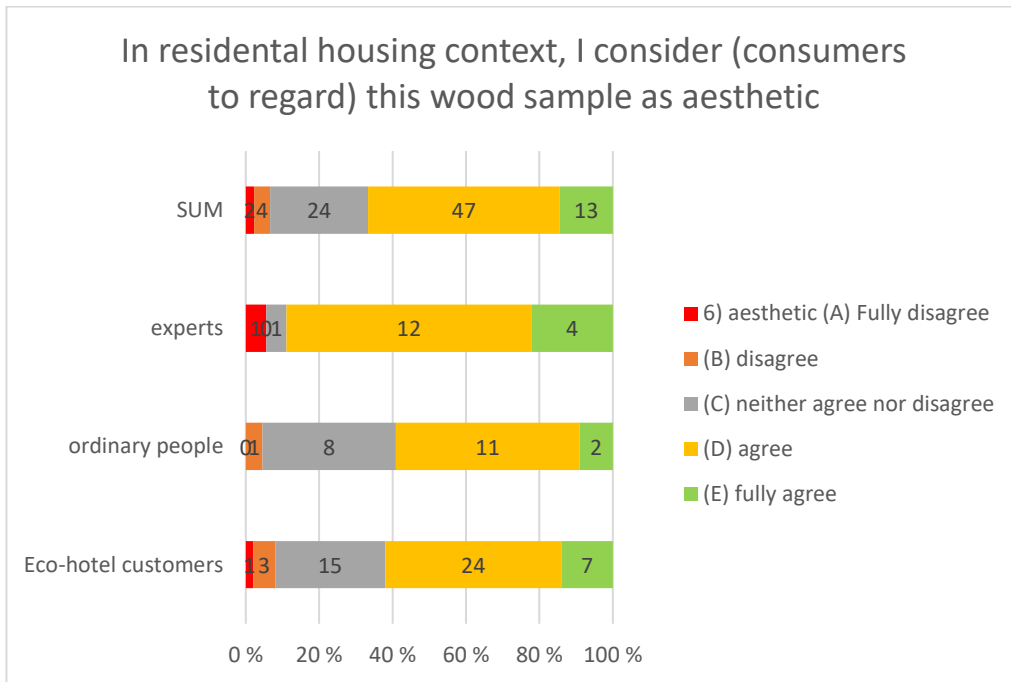


8. Sample A5 – pine wall panel, wall décor, round trim

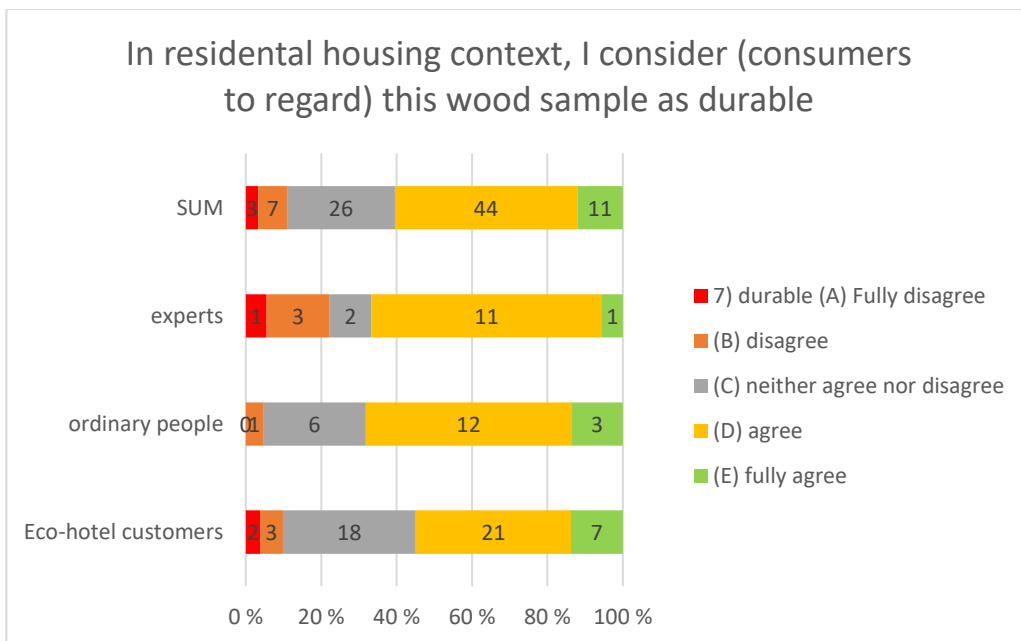




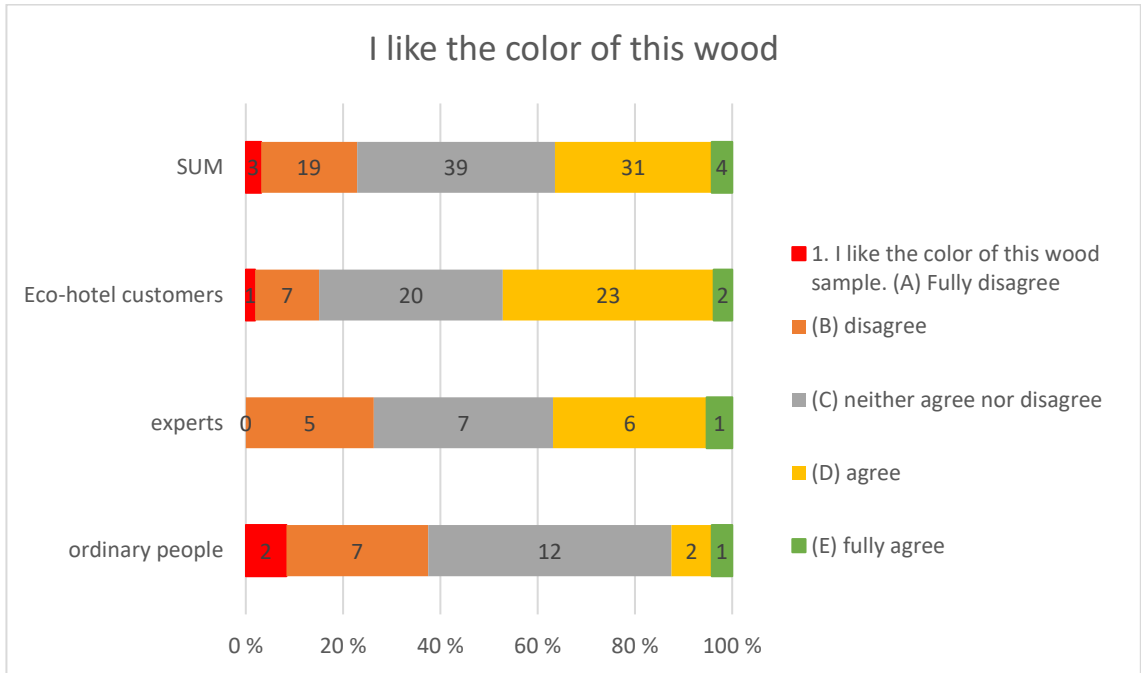
9. Sample A5 – pine wall panel, wall décor, round trim



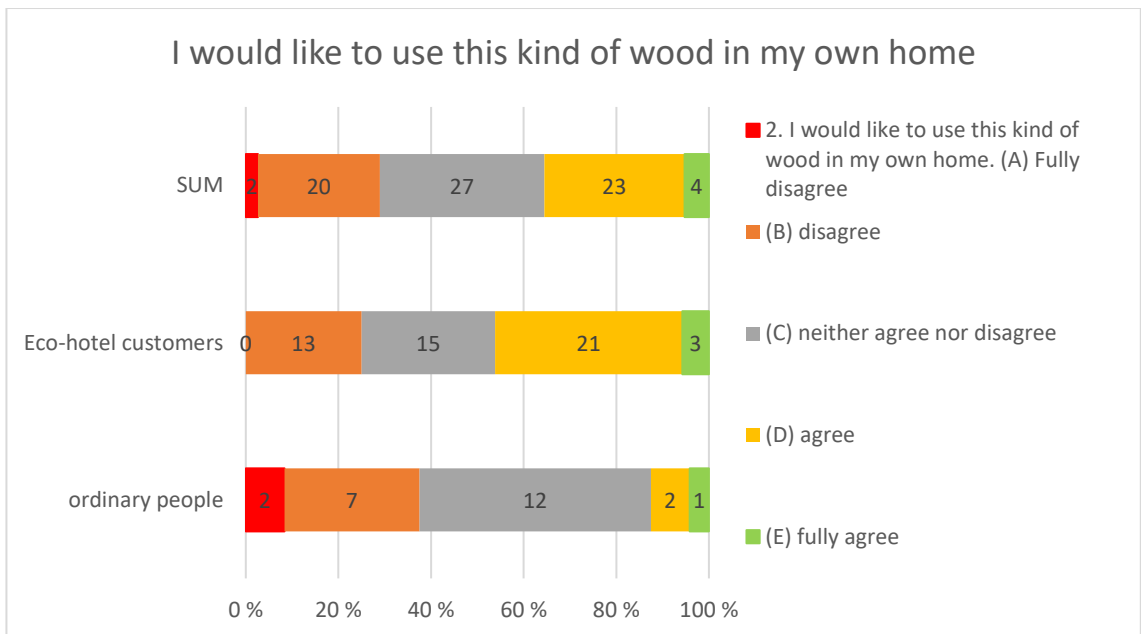
10. Sample A5 – pine wall panel, wall décor, round trim



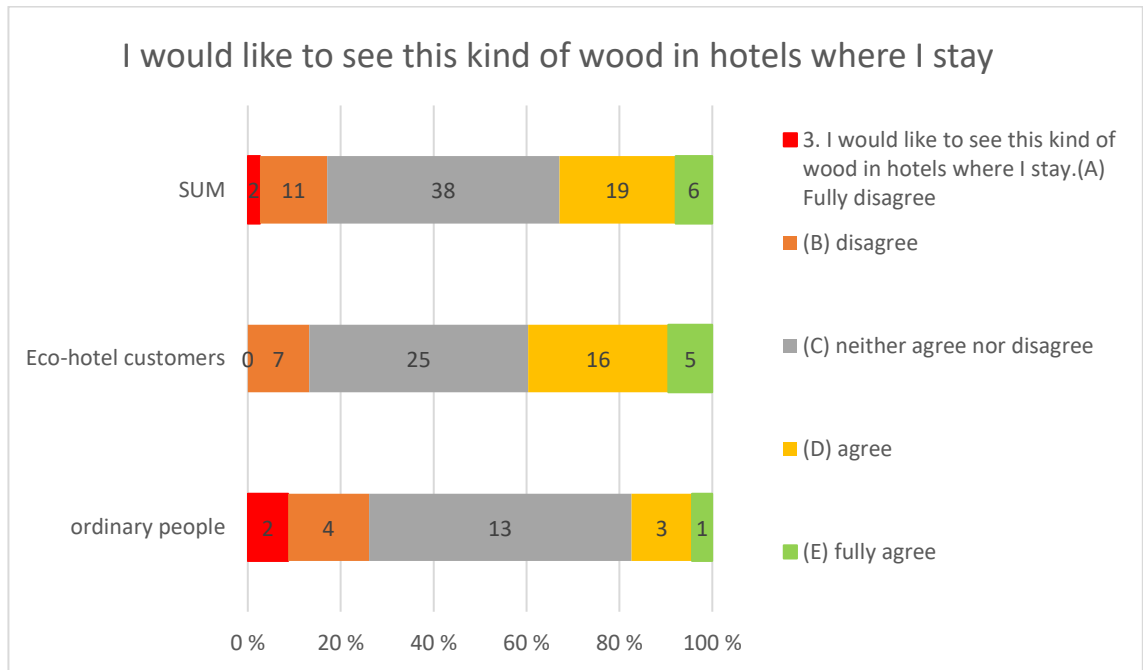
1. Sample B2 – Ash floor



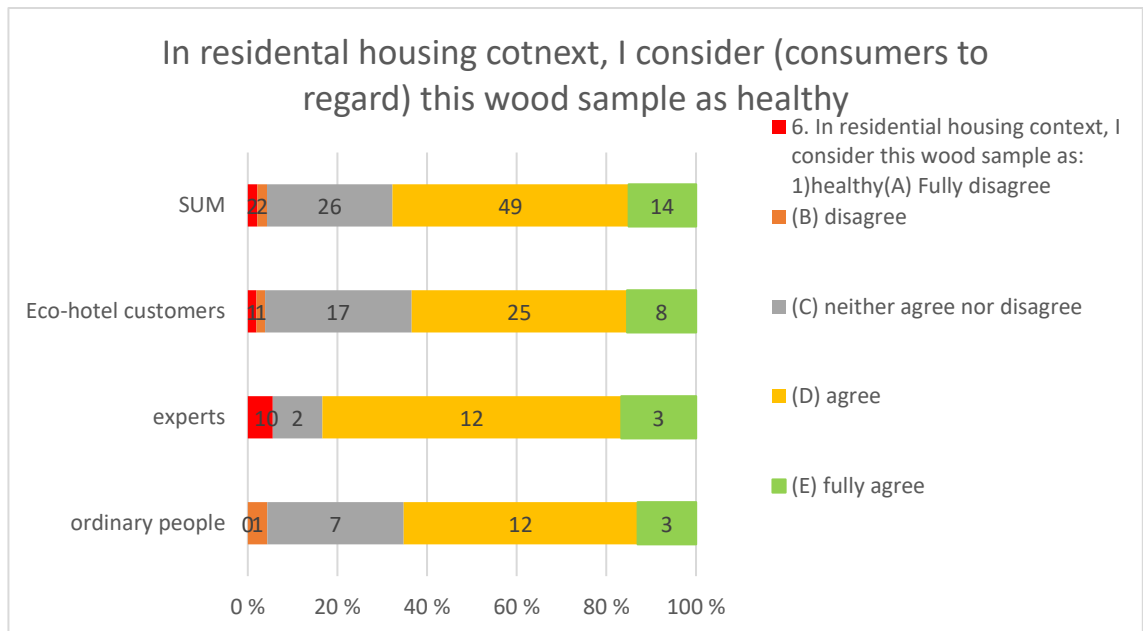
2. Sample B2 – Ash floor



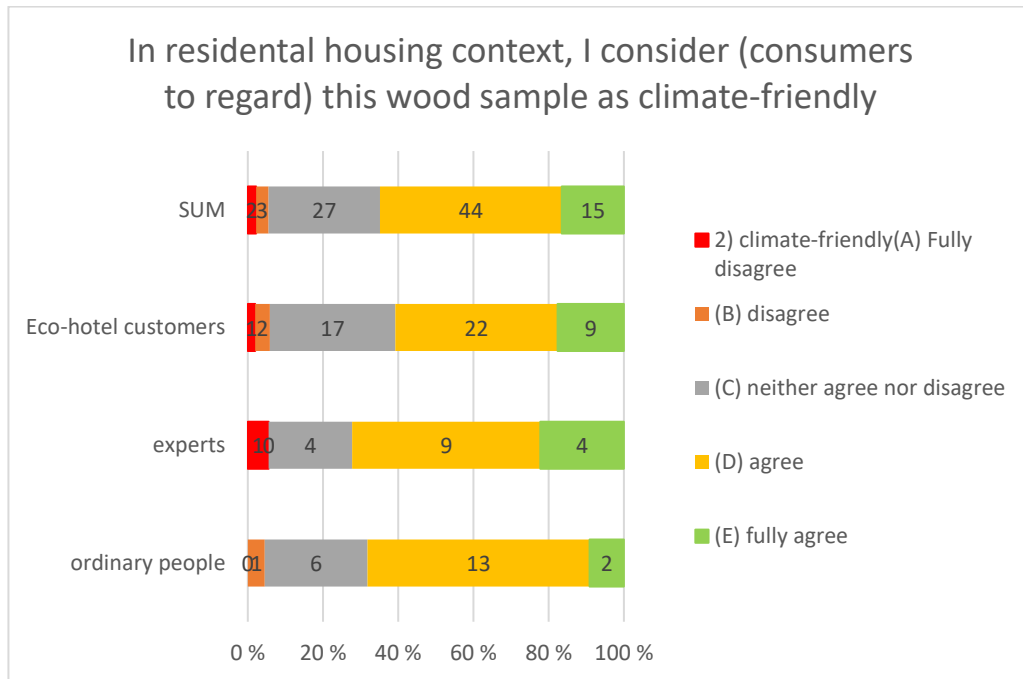
### 3. Sample B2 – Ash floor



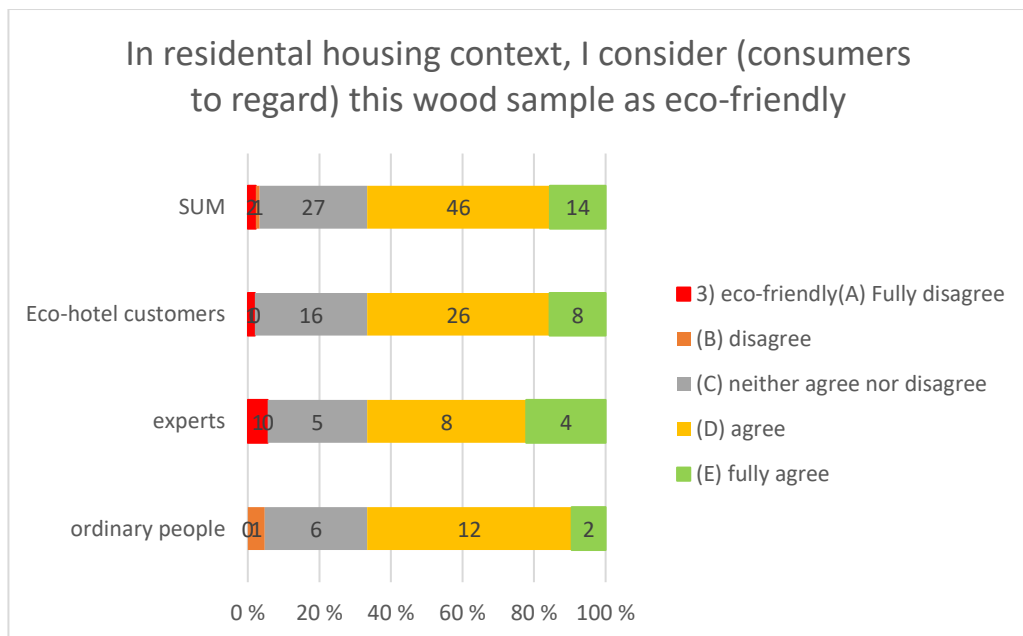
### 4. Sample B2 – Ash floor



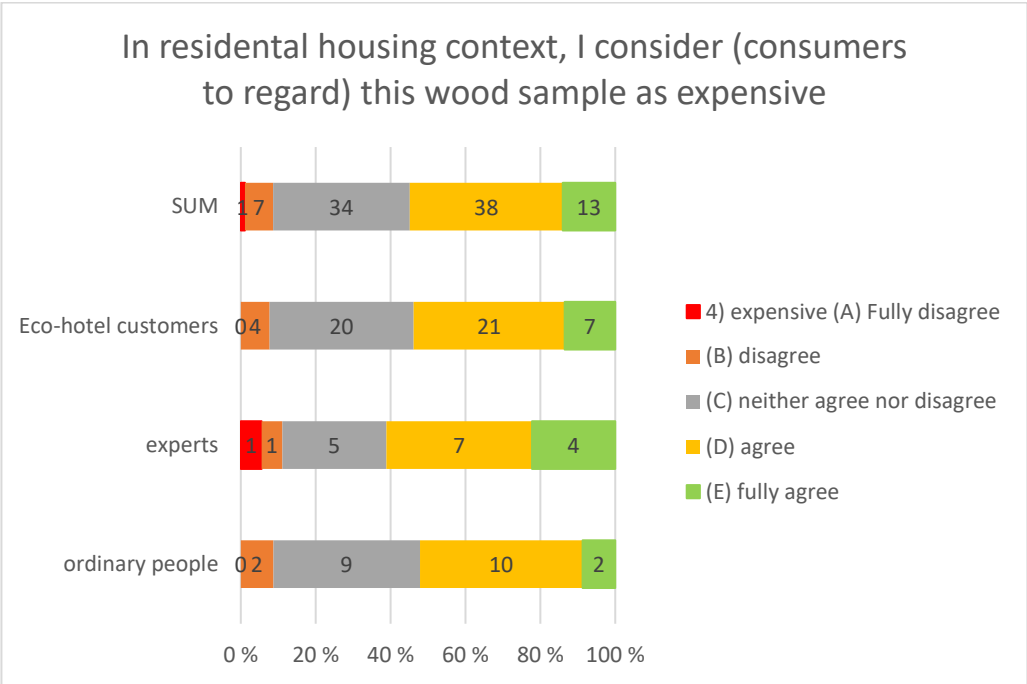
### 5. Sample B2 – Ash floor



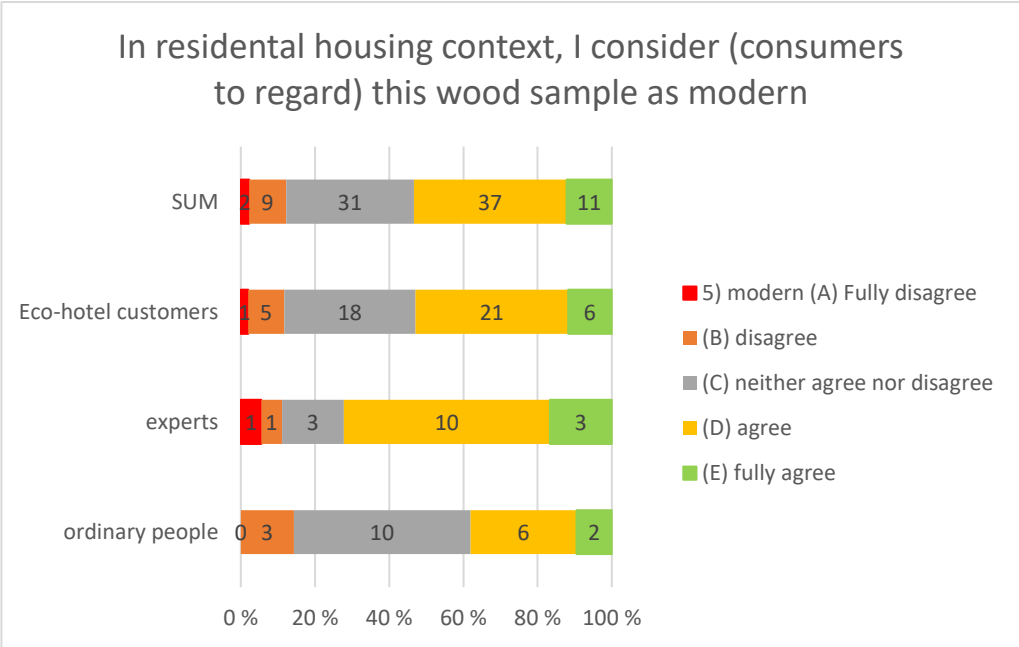
### 6. Sample B2 – Ash floor



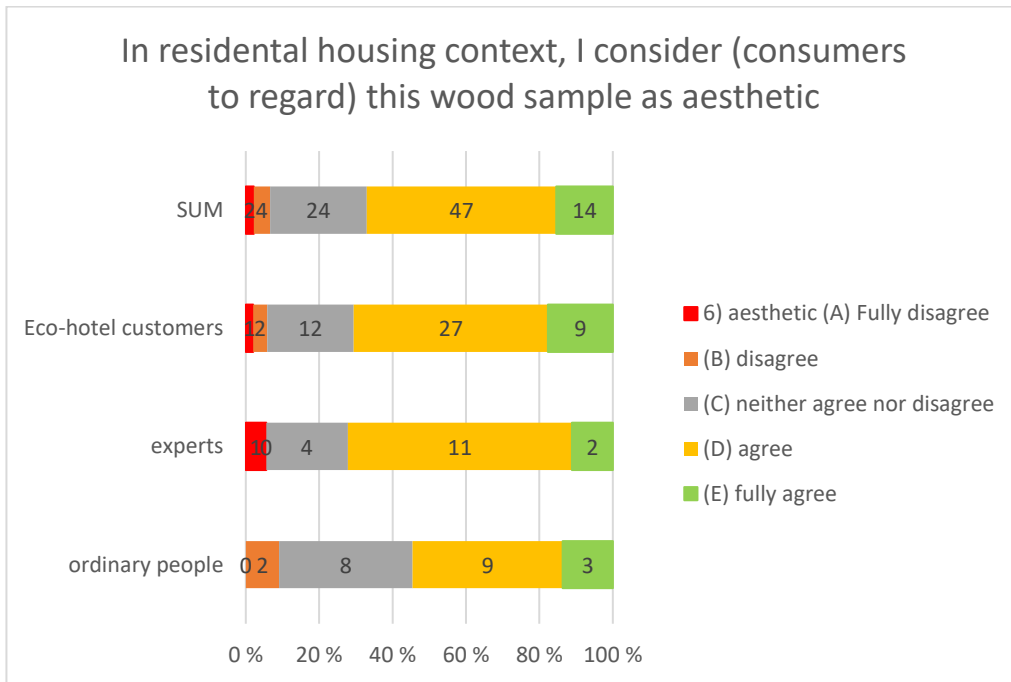
7. Sample B2 – Ash floor



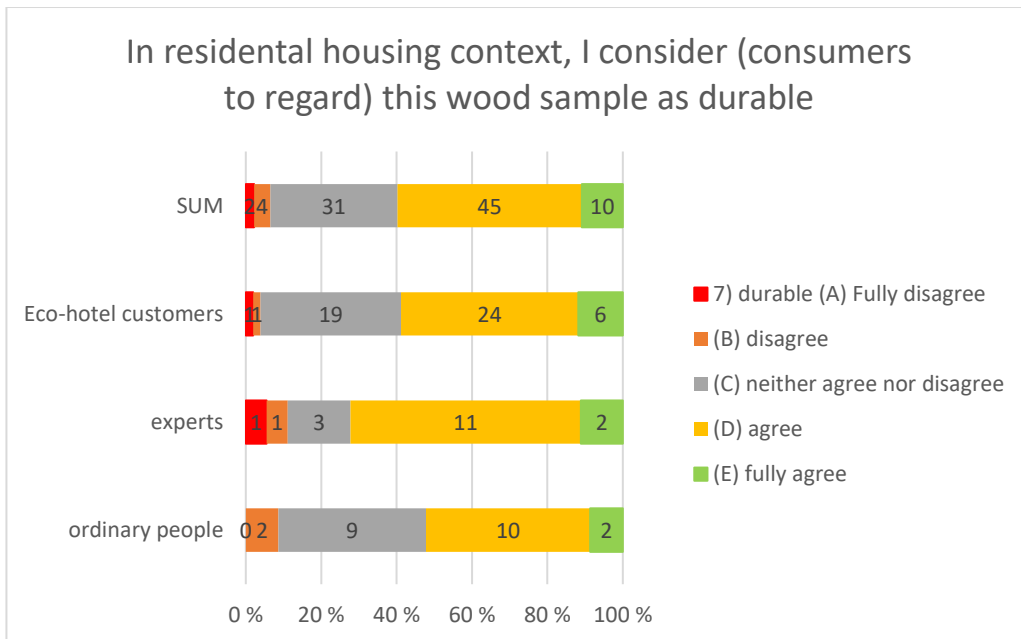
8. Sample B2 – Ash floor



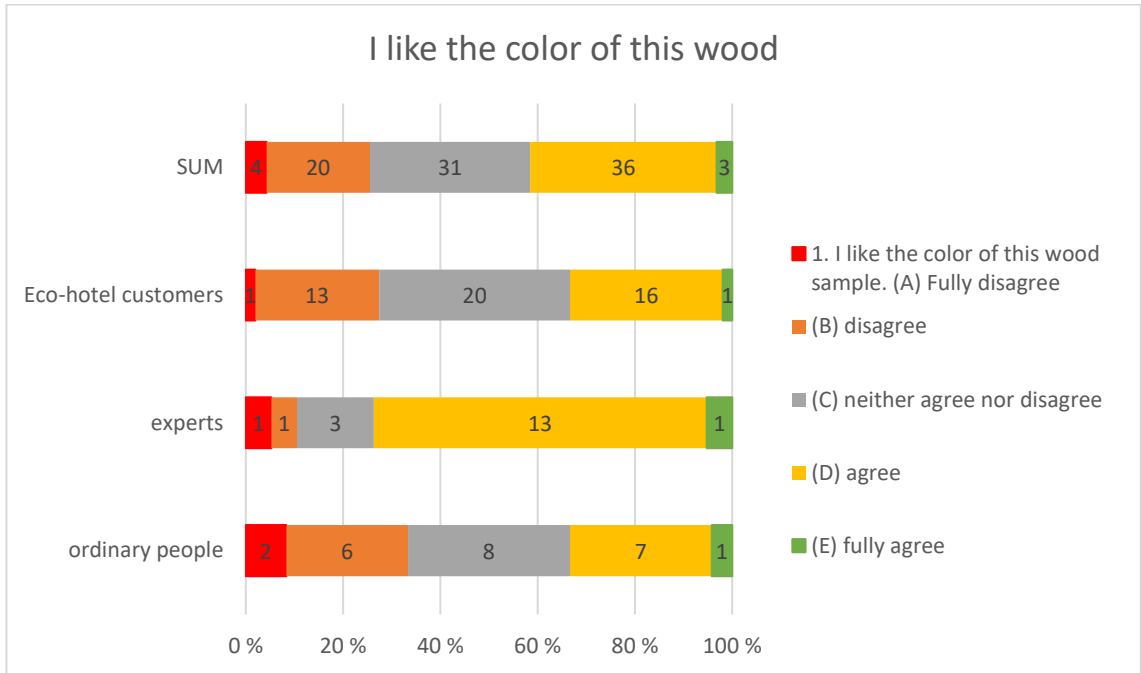
### 9. Sample B2 – Ash floor



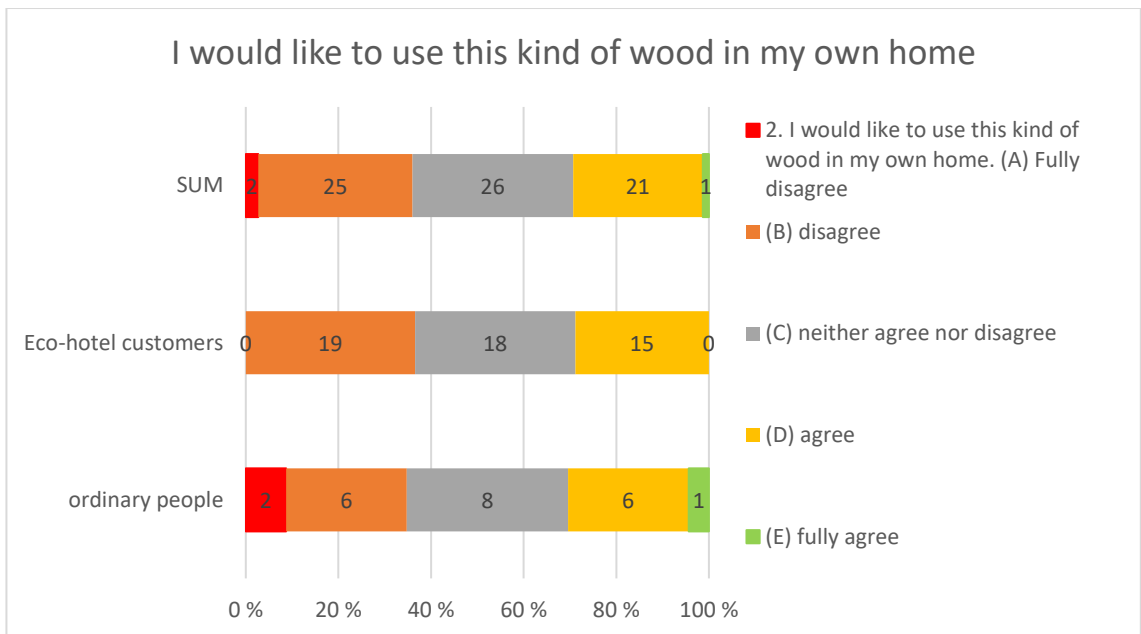
### 10. Sample B2 – Ash floor



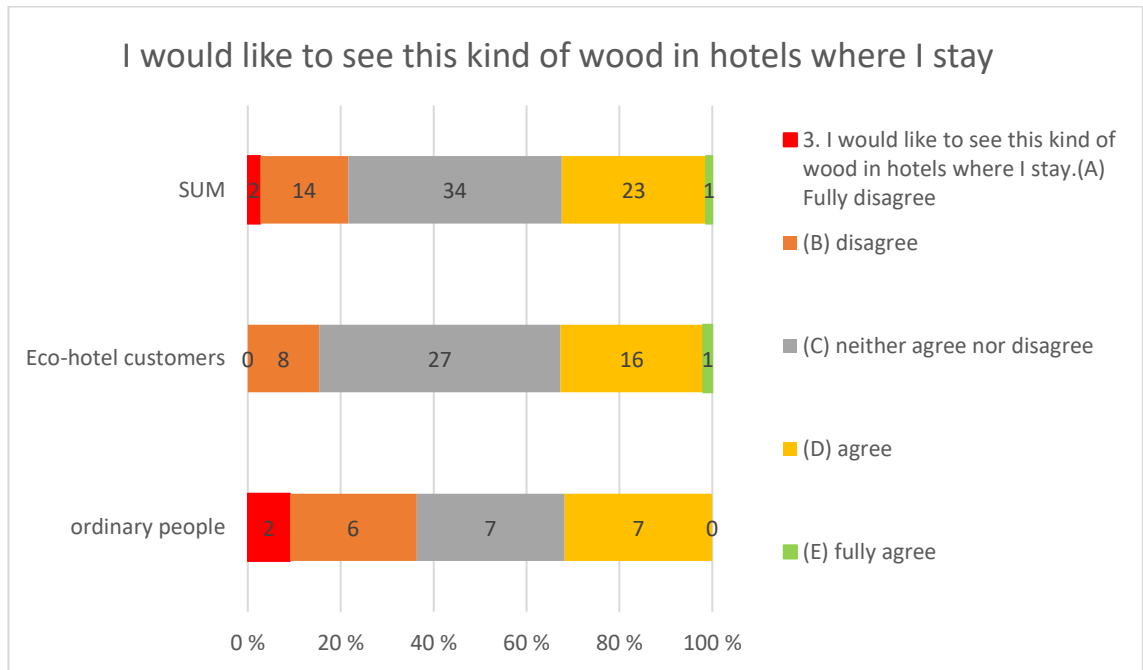
1. Sample B4 – birch natural, sanded and wax oiled



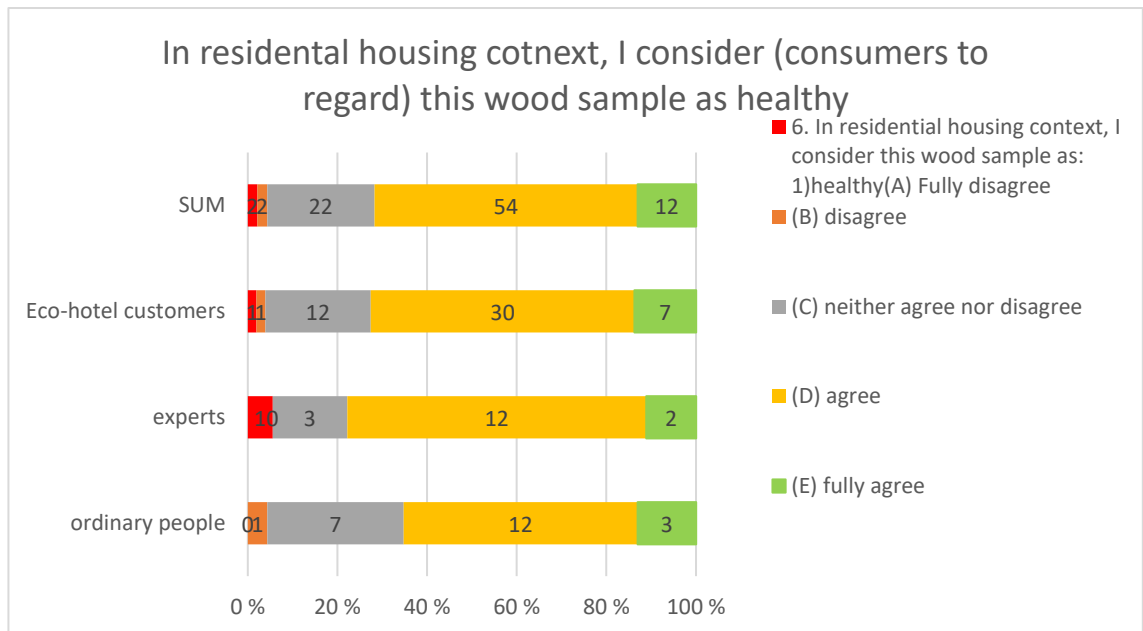
2. Sample B4 – birch natural, sanded and wax oiled



3. Sample B4 – birch natural, sanded and wax oiled

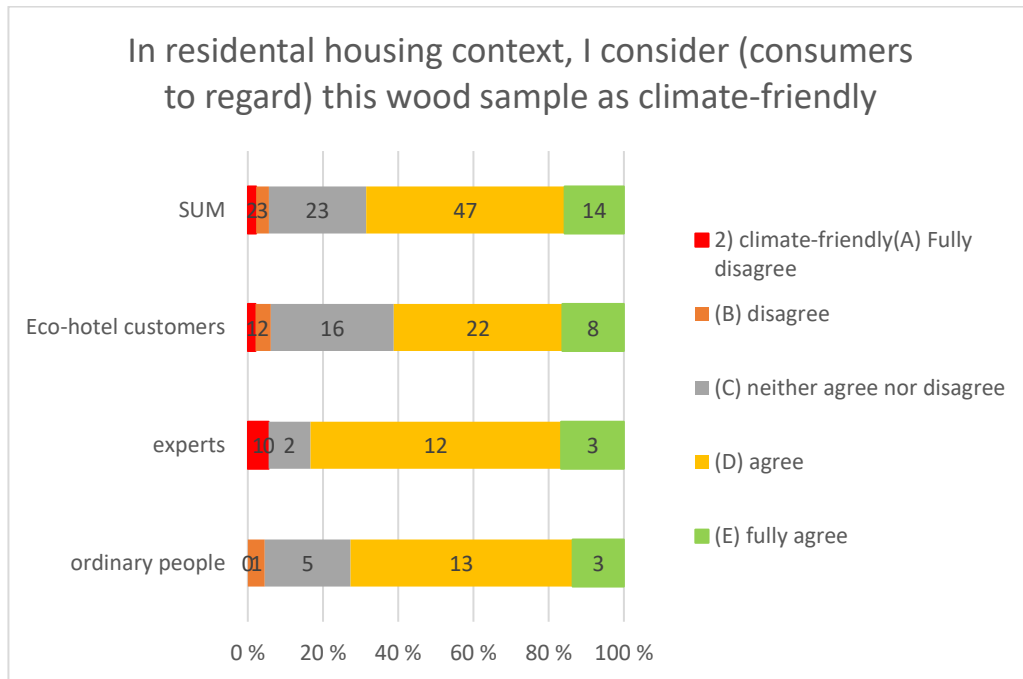


4. Sample B4 – birch natural, sanded and wax oiled

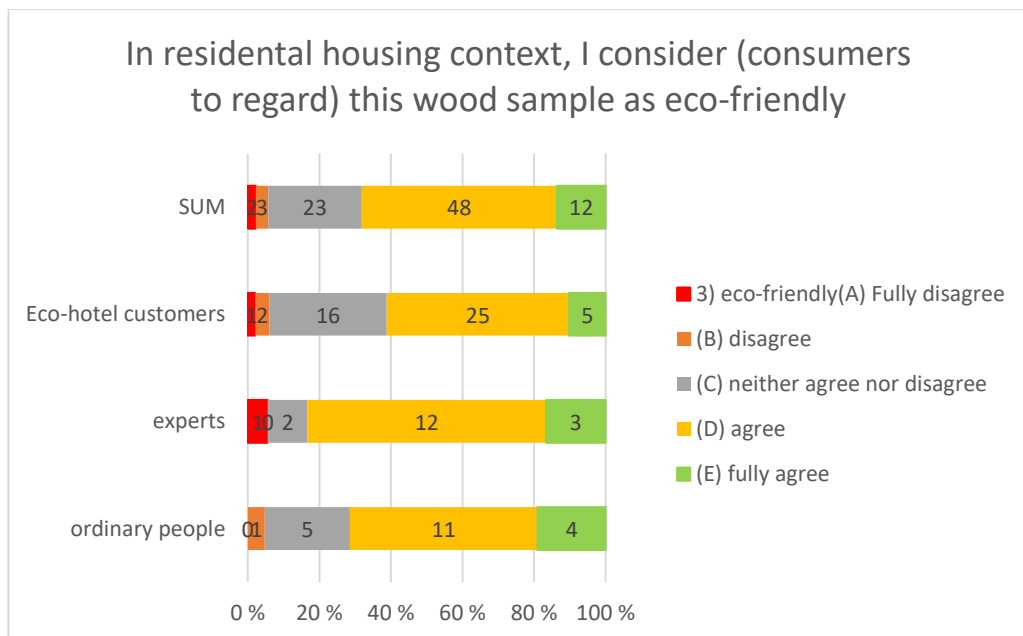




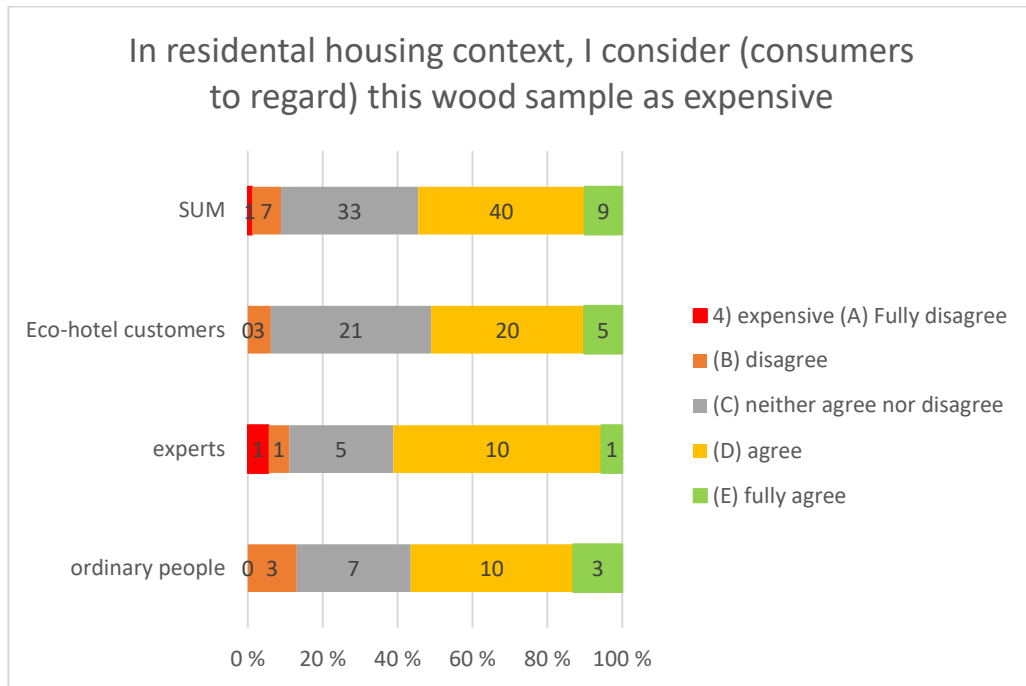
5. Sample B4 – birch natural, sanded and wax oiled



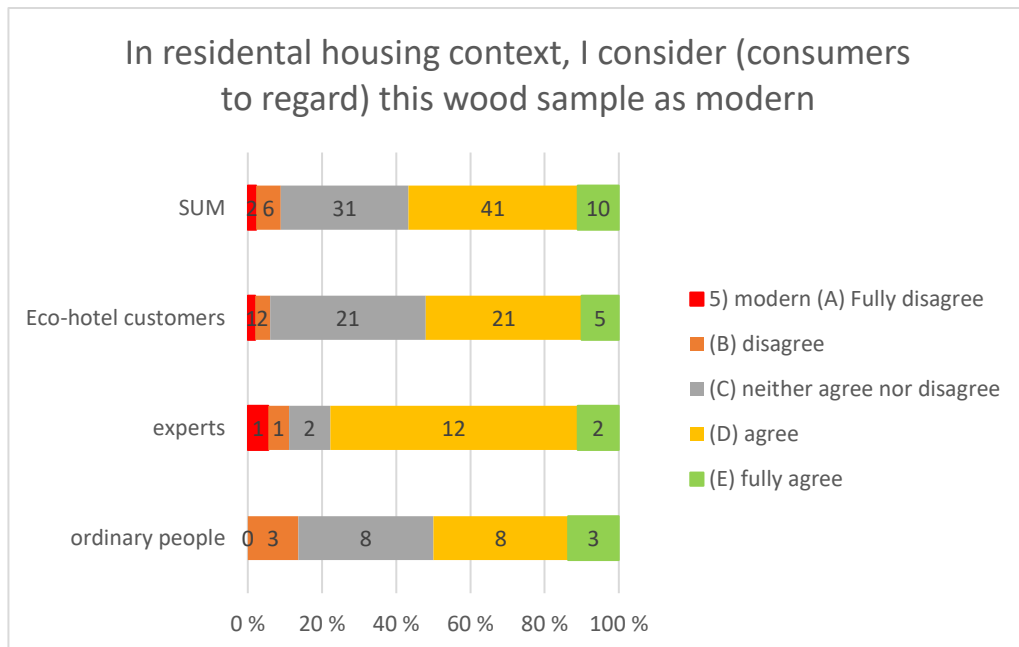
6. Sample B4 – birch natural, sanded and wax oiled



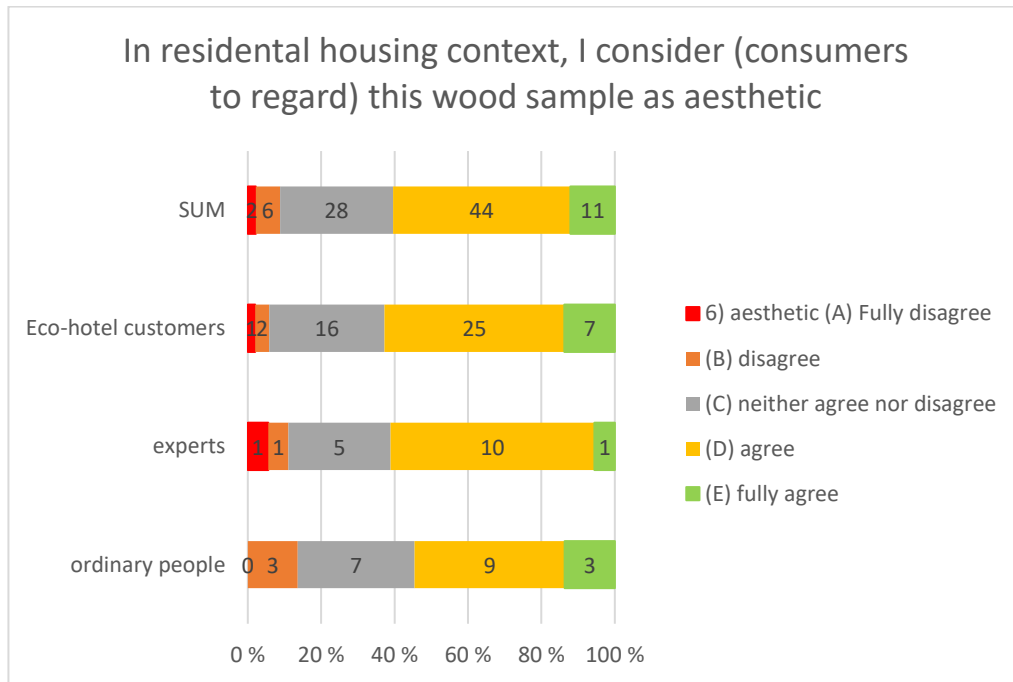
7. Sample B4 – birch natural, sanded and wax oiled



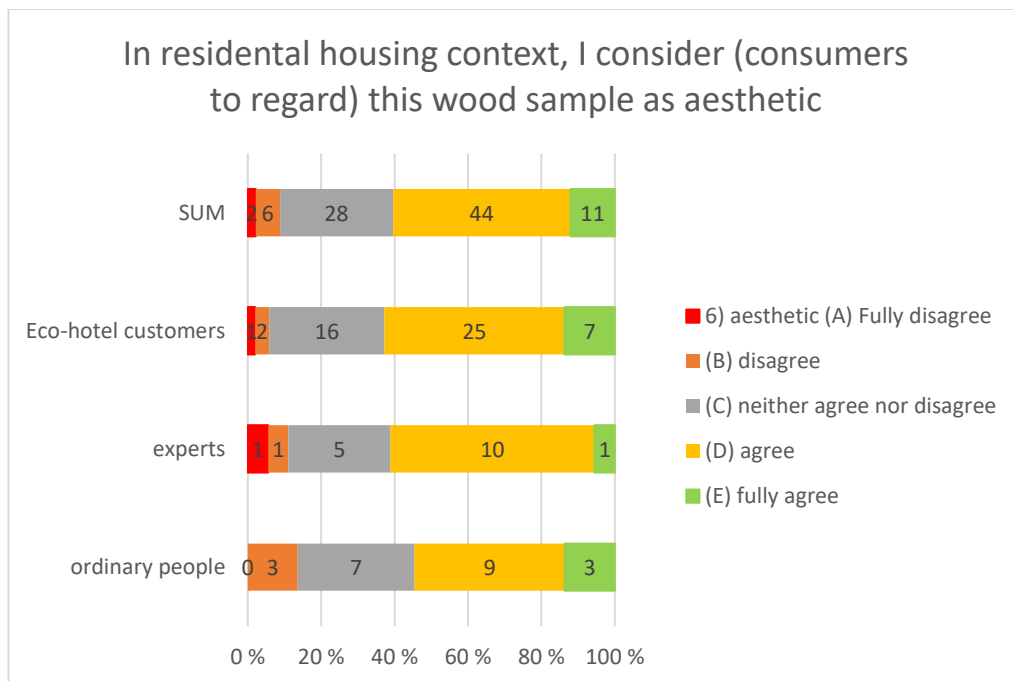
8. Sample B4 – birch natural, sanded and wax oiled



9. Sample B4 – birch natural, sanded and wax oiled



10. Sample B4 – birch natural, sanded and wax oiled



## ECOHOTEL CUSTOMERS SURVEY IN CHINA ON WOOD CONSTRUCTION, 3.6.2019

### I . GENERAL INFORMATION OF REpondENTS

1. Age:
2. Gender: (A) male (B) female
3. Occupation: (A) Public official (B) Manager of enterprise or institution  
(C) General staff of enterprise or institution  
(D) Private owner/individual (E) professional personnel/technician/teacher/doctor (F) soldier (G) farmer (H) student (I)freelancer (J) retired personnel.
4. Education: (A) junior high school and below (B) senior high school or technical secondary school (C) college  
(D) bachelor degree (E) master or above
5. Marital status: (A) married (B) unmarried  
(C) other
6. Average monthly income: (A) below 3000 yuan (B) 3001- 5000 yuan (C) 50001 - 8000 yuan (D) 8001- 10000 yuan (E) more than 10000 yuan
7. In which kind of room did you stay? (A) wooden cottage  
(B)hotel room
8. Who did you stay with in the hotel? (A) Family members (B) Alone

## II OPINIONS AND COGNITIVE ON WOOD CONSTRUCTION AND WOOD MATERIAL

- How do you evaluate your knowledge related to wood as construction or decoration material: (A) poor, (B) moderate (C) good, (D) very good, (E) excellent
- I chose this hotel because of

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree
wood construction					
environmental reasons					
health related reasons					
eco-friendliness					
something else					

- Please give your opinions on these following statements.

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
Climate change caused by the carbon dioxide increase in the air is one of the most serious threats of human beings.						
Climate change concerns me.						
Increase of forest area would reduce carbon dioxide from the air.						
Increasing use of wood as construction or decoration material would increase						

long term carbon storage capacity.						
I would like to see more wood construction in China.						
Advancing wood construction in China is important for sustainable development.						
Reaching climate goals in China requires more wood construction.						
Wood construction is the future direction of construction field in China.						
Wood construction could be further advanced in China						

#### 4. Wooden building construction should be advanced in China

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
in residential housing						
in office buildings						
in tourism housing						
on countryside						
in cities						

#### 5. Wood as decoration material (floor, wall, ceiling) should be advanced in China

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
in residential housing						
in office buildings						
in tourism housing						
on countryside						
in cities						

6. Wood as material for residential housing is...

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
healthy						
climate-friendly						
eco-friendly						
expensive						
modern						
aesthetic						
durable						
something else: please describe						

7. Please give your opinions on wood construction and decoration materials

- 1) What do you consider as the major advantages of wood construction?

Why? \_\_\_\_\_  
\_\_\_\_\_

- 2) What do you consider as the major advantages of wood as decoration material (floor, wall, ceiling)?

Why? \_\_\_\_\_  
\_\_\_\_\_

- 3) \_What do you consider as the major disadvantages of wood construction?  
Why?\_\_\_\_\_
- \_\_\_\_\_

8. Your personal experiences about wooden housing and wooden decoration

- 1) Have you ever lived in wooden housing? Yes/no. If yes, please describe your experience with a few words\_\_\_\_\_
- 2) Do you currently live in wooden housing? Yes/no. If yes, please describe your experience with a few words\_\_\_\_\_
- 3) Do you have wooden decoration (floor, wall, ceiling, etc) in your home. What?
- 4) I would like to live in wooden housing. (A) Fully disagree, (B) disagree, (C) neither agree nor disagree, (D) agree, (E) fully agree. Why yes/why no?\_\_\_\_\_

9. If you have any other comments on wood construction, please give your comments here\_\_\_\_\_

10. What comes first to your mind when you think of Finland?\_\_\_\_\_

What kind of other issues do you associate with Finland?\_\_\_\_\_

11. What comes first to your mind when you think of Europe?\_\_\_\_\_

What kind of other issues do you associate with Europe?\_\_\_\_\_

### III. SPECIFIC QUESTIONS FOR EACH WOOD SAMPLE:

**Number of the sample** 1 2 3 4 5 6 7 .....etc.

1. I like the color of this wood sample. (A) Fully disagree, (B) disagree, (C) neither agree nor disagree, (D) agree, (E) fully agree Why yes/why no?\_\_\_\_\_



2. I would like to use this kind of wood in my own home. (A) Fully disagree, (B) disagree, (C) neither agree nor disagree, (D) agree, (E) fully agree Why yes/why no?\_\_\_\_\_
3. I would like to see this kind of wood in hotels where I stay. (A) Fully disagree, (B) disagree, (C) neither agree nor disagree, (D) agree, (E) fully agree Why yes/why no?\_\_\_\_\_
4. What could be improved in this wood sample in order to make it more attractive to you?\_\_\_\_\_
5. What kind of qualities do you associate with this wood sample?\_\_\_\_\_
6. In residential housing context, I consider this wood sample as

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
healthy						
climate-friendly						
eco-friendly						
expensive						
modern						
aesthetic						
durable						
something else: please describe						

7. If you have any other comments on this wood sample, please give your comments here\_\_\_\_\_

Thank you for your valuable participation in this survey!

**EXPERT SURVEY IN CHINA ON WOOD CONSTRUCTION, 3.6.2019**

**I . GENERAL INFORMATION OF REpondENTS**

1. Age:
2. Gender: (A) male (B) female
3. Occupation: (A) Public official (B) Manager of enterprise or institution (C) General staff of enterprise or institution (D) Private owner/individual (E) professional personnel/technician/teacher/doctor (F) soldier (G) farmer (H) student (I)freelancer (J) retired personnel.
4. Education: (A) junior high school and below school or technical secondary school (B) senior high school (C) college (D) bachelor degree (E) master or above
5. Marital status: (A) married (B) unmarried (C) other
6. Average monthly income: (A) below 3000 yuan (B) 3001- 5000 yuan (C) 50001 - 8000 yuan (D) 8001- 10000 yuan (E) more than 10000 yuan
7. Background discipline:

**II OPINIONS AND COGNITITVE ON WOOD CONSTRUCTION AND WOOD MATERIAL**

1. How do you evaluate your expertise of wood construction. (A) poor, (B) moderate, (C) good, (D) very good, (E) excellent
2. Please give your opinions on wood construction.
  - 1) What do you consider as the major advantages of wood construction?  
Why? \_\_\_\_\_
  - 
  - 2) What do you consider as the major disadvantages of wood construction?  
Why? \_\_\_\_\_

3) What do you consider as the major driving forces of wood construction?

Why? \_\_\_\_\_

–

4) What do you consider as the major barriers of wood construction?

Why? \_\_\_\_\_

3. Please give your opinions on these following statements.

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
Climate change caused by the carbon dioxide increase in the air is one of the most serious threats of human beings.						
Climate change concerns me.						
Increase of forest area would reduce carbon dioxide from the air.						
Advancing wood construction in China is important for me.						
Advancing wood construction in China is important for sustainable development.						
Reaching climate goals in China requires more wood construction.						
Wood construction is the future direction of construction field in China.						
Advancing wood construction in China would increase long term carbon storage capacity.						
Wood construction could be further advanced in China						

## 4. Wooden building construction should be advanced in China

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
in residential housing						
in office buildings						
in tourism housing						
on countryside						
in cities						

## 5. Wood as decoration material (floor, wall, ceiling) should be advanced in China

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
in residential housing						
in office buildings						
in tourism housing						
on countryside						
in cities						

## 6. Wood as material for residential housing is...

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
healthy						
climate-friendly						
eco-friendly						
expensive						
modern						
aesthetic						
durable						
something else: please describe						

## 7. Your personal experiences about wooden housing and wooden decoration

- 1) Have you ever lived in wooden housing? Yes/no. If yes, please describe your experience with a few words \_\_\_\_\_
- 2) Do you currently live in wooden housing? Yes/no. If yes, please describe your experience with a few words \_\_\_\_\_
- 3) I would like to live in wooden housing. (A) Fully disagree, (B) disagree, (C) neither agree nor disagree, (D) agree, (E) fully agree. Why yes/why no? \_\_\_\_\_
- 4) Do you have wooden decoration (floor, wall, ceiling) in your home, what:  
\_\_\_\_\_

8. If you have any other comments on wood construction, please give your comments here \_\_\_\_\_

## 9. What comes first to your mind when you think of

Finland? \_\_\_\_\_ What kind of other issues do you associate with Finland? \_\_\_\_\_ To which consumer groups "Finnish" would be attractive to? \_\_\_\_\_

## 10. What comes first to your mind when you think of

Europe? \_\_\_\_\_ What kind of other issues do you associate with Europe? \_\_\_\_\_ To which consumer groups "European" would be attractive to? \_\_\_\_\_

**III. SPECIFIC QUESTIONS FOR EACH WOOD SAMPLE:**

**Number of the sample 1 2 3 4 5 6 7 .....etc.**

1. I like the color of this wood sample. (A) Fully disagree, (B) disagree, (C) neither agree nor disagree, (D) agree, (E) fully agree Why yes/why no? \_\_\_\_\_
2. Which kind of consumer groups do you consider as potential buyers for this kind of wood? \_\_\_\_\_
3. What could be improved in this wood sample in order to make it more attractive to consumers? \_\_\_\_\_
4. What kind of qualities do you associate with this wood sample? \_\_\_\_\_
5. In residential housing context, I consider consumers to regard this wood sample as

Options	Fully disagree	disagree	neither agree nor disagree	agree	fully agree	Why
healthy						
climate-friendly						
eco-friendly						
expensive						
modern						
aesthetic						
durable						
something else: please describe						

6. If you have any other comments on this wood sample, please give your comments here \_\_\_\_\_

Thank you for your valuable participation in this survey