Chapter 4. CASE STUDY ON THE PLYWOOD INDUSTRY IN CHINA[8]

Preface

This project was a follow-up to a workshop on China's Forest Products Statistics conducted by the Food and Agriculture Organization of the United Nations (FAO), the International Tropical Timber Organization (ITTO) and the Asia-Pacific Forest Network for Sustainable Management and Rehabilitation (APFNet) in Haikou, China from 1-3 April, 2013. This study has assessed the history and present status of the plywood industry in China by completing a detailed literature review, expert interviews, and analysing completed questionnaires from 308 plywood mills (including on-site visits of several mills by project members). This report is a synthesis of the major findings from the study.

Overview

Product description

Plywood refers to manufactured panels made up of three or more thin plies (layers) of rotary peeled or sliced veneer that are glued and pressed together with the grains of adjacent layers arranged at right angles. According to FAO's definition, plywood also includes blockboard, which is made of a core of wooden blocks (not veneer) that are glued together and covered with quality veneer on both sides through compression using machines. Plywood has many advantages over other wood products, including dimensional stability, availability in large sizes, good decorative features, and excellent workability. It is largely used to make furniture (more than 60 percent), but also for interior decorating, moulding, wood flooring, doors and windows, packaging materials, interior panelling, and renovation.

History

The development of China's plywood industry can be divided into five eras:

1. 1920-1949: The industry was in its infancy; plywood production in 1949 was only 16 900 m^3.
2. 1950-1980: Most plywood was produced in forested regions, mainly in the northeast (Heilongjiang, Jilin and Liaoning provinces) and southeast (Shanghai, Jiangxi and Fujian). Total production in 1980 was 330 000 m^3, with an average annual increase of 10 400 m^3.
3. 1981-1990: The industry – mostly concentrated in Guangdong province but also present in Hebei and Shandong – was growing rapidly. Plywood production in 1990 was 759 000 m^3, with average growth of 41 000 m^3 a year.
4. 1991-2000: Plywood production was developing in Zhejiang and Jiangsu provinces. Several private enterprises emerged to form clusters. Production in 2000 was 9.9 million m^3, with an average annual increase of 888 000 m^3.
5. 2001-present: The plywood industry has grown exponentially. China had a trade surplus of plywood by volume in 2001 and by value in 2002. In 2003 the country became the largest producer in the world, producing 165.5 million m^3 in 2015 with an average annual increase of 15.8 million m^3. However, since 2008 production has shifted away from Hebei and Zhejiang provinces to Guangxi province. This is the largest forestry province in the country and has become a new cluster for plywood production.

Since 2000 the plywood industry has developed rapidly and gone through three main transitions.

1. The location has moved from the forested regions to the economically developed regions.
2. Ownership has shifted from state-owned enterprises to private enterprises.
3. The source of raw material has shifted from natural forests to plantation forests.

Despite China's status as the largest producer and exporter of plywood in the world, it is still behind other advanced countries in terms of milling technology and staff training.

China plywood industries

Main production regions

Before the reforms in China, all plywood industries were state-owned enterprises, mainly located in regions where there were wood industries. They constituted both producers and retailers, with raw materials coming primarily from state-produced logs. Beijing, Tianjin and Shanghai were the main consumers of plywood. With the implementation of the natural forest protection programme, the main plywood production regions have moved from the northeast (Heilongjiang, Jilin and Liaoning) and southeast (Jiangxi and Fujian), where forest resources were sufficient, to Hebei, Shandong, Jiangsu and Zhejiang provinces, where the economy was well-developed but natural forest resources were not necessarily adequate. However, as fast-growing plantations were numerous in these provinces, there were plenty of raw materials and availability of low-cost labour, which aided the development of the industry.

China's main regions of plywood production are now centred in the eastern and southern coastal provinces, where the processes of plywood production are implemented across different mills, some of which are specialized in processing veneer, some in processing plywood, and others in processing overlaid plywood. These different mills, just like continuous workshops in the plywood production line, form large plywood clusters, and these clusters provide financial assistance, efficient utilization of wood and other materials. They also form a network of economies of scale and attract further investment in infrastructure, thus helping to reduce production costs and market risks, and strengthening the competitive advantages of the individual enterprises within the clusters.

Such structures have been established in Linyi in Shandong province and Pizhou in Jiangsu province. The main clusters of plywood industries are provided in Figure 4.1.

China's main blockboard industry is distributed across five regions: east, north, central, south and northeast (see Figure 4.2).

[8] Study undertaken by the Research Institute of Forestry Policy and Information, Chinese Academy of Forestry, Beijing, China

Figure 4.1: Distribution of plywood clusters

Main plywood cluster

Figure 4.2: Top five provinces of the blockboard industry

Owing to the relatively low manufacturing costs of blockboard and the simplicity of producing and marketing, more than 95 percent of the production industries are small enterprises

Overview of China's current plywood enterprises

Few accurate statistics are available on the actual number of plywood mills in China. Most experts agree that there are about 3 000 mills equipped with a plywood production line, and tens of thousands of veneer-peeling mills (Chen, 2013). These enterprises can be divided into three size categories.

1. Large enterprises: These are located in coastal cities in Shanghai, Jiangsu and Guangdong provinces, most of them foreign-funded or shareholding enterprises established in recent decades. Annual productivity is 50 000-200 000 m^3. Raw materials are mainly imported logs or veneer. These mills have advanced technology and represent the highest level of quality in China. The average annual production capacity of large enterprises is more than 30 000 m^3.
2. Medium-sized enterprises: These are mainly found in Zhejiang, Shandong and other inland provinces. Investment is usually around several million CNY. Face veneer is mostly imported, and core veneer is produced domestically. Quality is mediocre, and the average annual production capacity is 10 000-30 000 m^3.
3. Small enterprises: Most plywood products in China are made by these enterprises. They are mostly situated in Jiangsu, Fujian, Shandong and Hebei provinces. Their investment scale is quite low – less than CNY100 000 (US$156 600) – and they use simple equipment. Products are not of such high quality and are mainly used for concrete forming in construction and as materials of low-quality furniture and decorative panels. They belong to the low-end products in the international market, with an advantage in price. They mostly maintain a simple replication of existing technologies, making it difficult to raise their competitiveness through innovation. Most of these enterprises are original equipment manufacturers (OEMs) for foreign trade companies, so their production is sensitive to the changes of external markets. The average annual production capacity is 5 000-10 000 m^3.

Production of plywood and blockboard[9]

According to the latest data from the *China Statistic Yearbook of Forestry* (2015), Shandong province is the largest plywood production base in China; in 2015, it produced 48.4 million m^3, accounting for 29 percent of the country's total output. It is followed by Jiangsu, Guangxi, Anhui and Guangdong provinces, the combined production of which accounted for 76 percent of the country's total production (see Table 4.1 and Figure 4.3).

Figure 4.3: Top five provinces of plywood production, 2015

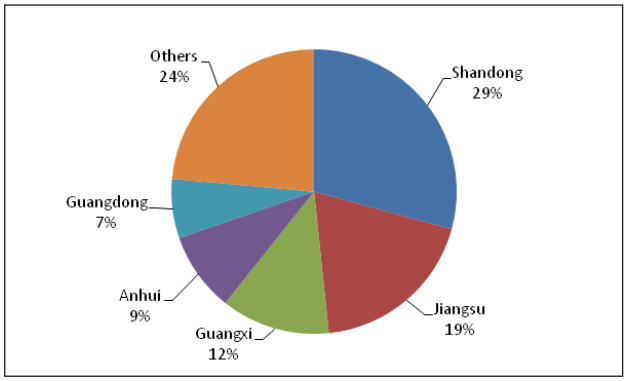


Table 4.1 Top five provinces of plywood production, 2013-2015 (million m^3)

Provinces	2013	2014	2015	2015 Percentage (%)
National	**137.3**	**149.7**	**165.5**	**100**
Shandong	44.1	46.3	48.4	29
Jiangsu	28	31.8	31.6	19
Guangxi	17.2	16.4	20.5	12
Anhui	10.1	12.8	14.9	9
Guangdong	2.5	3.3	11.1	7

Source: *China Statistic Yearbook of Forestry,* 2015.

Jiangsu is the largest blockboard production base in China, producing 3.4 million m^3 (16 percent of the total national production) in 2015. It is followed by Zhejiang, Hebei, Guangxi and Shangdong. The blockboard production of these five provinces together accounted for 62 percent of the national total (see Table 4.2 and Figure 4.4).

[9] The plywood production data presented in this chapter may not correspond with ITTO estimates presented in Appendix 1 of this report. Consultations were underway with the government of China regarding the data presented in this preliminary study at the time of finalizing the Biennial Review. Any revisions or comments on China's tropical plywood production resulting from these consultations will be posted in due course on www.itto.int

Figure 4.4: Top five provinces of blockboard production, 2015

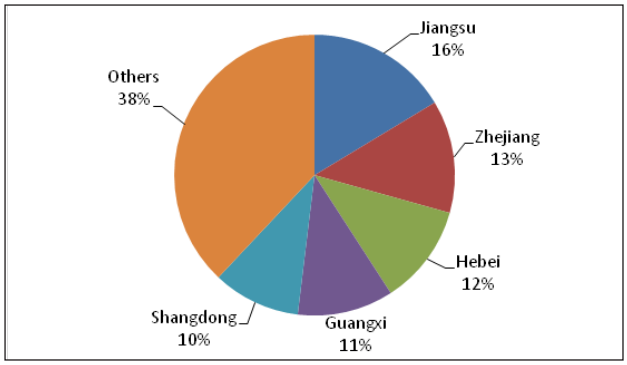


Table 4.2 Top five provinces of blockboard production, 2013-2015 (million m³)				
Provinces	**2013**	**2014**	**2015**	**2015 Percentage (%)**
National	**21.2**	**23.9**	**20.8**	**100**
Jiangsu	3.2	3.7	3.4	16
Zhejiang	2.8	2.9	2.7	13
Hebei	2.1	2.5	2.4	12
Guangxi	2	2.7	2.3	11
Shangdong	1.4	2.6	2.1	10

Source: *China Statistic Yearbook of Forestry,* 2015.

In terms of combined production of plywood and blockboard, Shandong is still the largest base. It is followed by Jiangsu, Guangxi, Anhui and Hebei, the combined production of which accounted for 74 percent of the national total (see Table 4.3 and Figure 4.5).

Figure 4.5: Top five provinces of the total production of plywood and blockboard, 2015

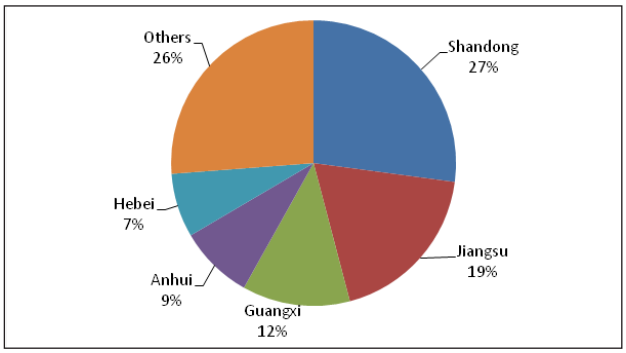


Table 4.3 Top five provinces of the total production of plywood and blockboard, 2013-2015 (million m³)				
Provinces	**2013**	**2014**	**2015**	**2015 Percentage (%)**
National	**158.4**	**173.6**	**186.3**	**100**
Shandong	45.5	48.9	50.5	27
Jiangsu	31.2	35.5	35	19
Guangxi	19.2	19.1	22.8	12
Anhui	13.1	14.5	15.7	8
Hebei	7.2	11.6	13.5	7

Source: *China Statistic Yearbook of Forestry,* 2015.

Processing procedures

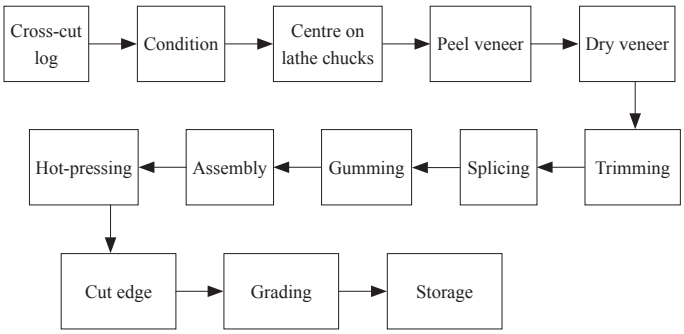
a) Plywood

In China, dry heat is used to dry the peeled veneer to between 8 and 12 percent moisture content dry (mcd), followed by gluing, assembly (layup) and compression into plywood using thermo-compressing machines. The procedures include four steps.

1. Log preparation: Logs are debarked and cut into designated lengths according to the required sizes of plywood products to get the best quality of veneer and maximize log volume utilization. They are then treated with warm water to soften the wood and increase its plasticity, hence its peeling ability and veneer quality.
2. Veneering: The wood sections are generally peeled with a lathe to obtain veneers. More than 95 percent of veneer in China is made by peeling and less than 5 percent by slicing. All enterprises surveyed in this study used a lathe. The wood sections need to be centred before being put into the lathe (to maximize the yield of the full-sized veneer). After the peeling process the veneer is dried. In this study, most of the plywood mills procure veneer from small producers in nearby areas. These family workshop-style factories have no equipment for drying wood; they dry them naturally. Veneer usually needs to be dried to 8-12 percent mcd, after which it is cut to predetermined sizes, and small pieces are put together to form full-size sheets. Finally, they are further repaired and processed, which includes seaming, joining, and filling holes and splits. This part of the process is particularly time-consuming, accounting for 35-40 percent of the total work hours.
3. Gluing: This is a critical step whereby glue is applied to the surface of the veneer to produce the required number of plies and panel thickness. They are then thermo-compressed. For normal plywood, the dosage of glue is about 80-90 kg/m³ (liquid) for class I plywood, 90-100 kg/m³ (liquid) for class II plywood and 30-35 kg/m³ (solid) for class III plywood.
4. Finishing: This consists of trimming, sanding and quality control, whereby size is checked for consistency, and the overall quality and appearance are controlled according to national standards.

Most plywood mills follow these procedures (see Figure 4.6).

Figure 4.6: Production process



b) Blockboard

The production of blockboard consists of three main steps: veneer making (which is the same procedure as for normal plywood), core veneer making and gluing.

Coreboard production: The enterprises surveyed in this study mainly used poplar and paulownia in north China and eucalypts in the south. To maintain the stability of the panel, the coreboards for the blockboard should be the same species or have similar physical properties. The core is made by sawing uniform strips

from the wood, applying glue to the surface and laminating them together with a press.

Applying board: Glue is applied to each side of the coreboard, and veneer is applied to both sides of the blockboard panel. The panels are then thermo-compressed to laminate the core and surface veneer panels together.

Sources of raw materials for plywood production

The use of basswood, birch and Manchurian ash for plywood production was stopped when China began to liberalize its economy. From the 1980s to the early 1990s the importing of wood for plywood production was considered a lucrative business and attracted many investors. Currently, wood produced from fast-growing plantations is widely used in China's plywood sector. According to expert estimates, about 70 percent (50 percent from poplar and 20 percent from eucalyptus) of the country's plywood production comes from plantations.

In terms of the species used for plywood production, domestically produced wood comes primarily from poplars, eucalypts, Manchurian ash, basswoods, *Alniphyllum fortunei,* paulownia, rubberwood, Chinese cherry, sweet gum, maples, elms, oaks, birches, masson pine, Yunnan pine, larches and spruces. Imported wood is mainly from *Eucalyptus saligna,* mahogany and radiata pine.

Large broadleaved trees are used for the face veneer of plywood and block wood, with the core veneer and the base board mostly being poplar and eucalypts from fast growing plantations. The face veneer for plywood is normally 0.1-0.6 mm thick. For a standard-sized plywood about 9 mm thick with a face veneer of 0.3mm thick, the face veneer, core veneer and the base veneer account for approximated 3.3 percent, 93.3 percent and 3.3 percent of the total volume of the plywood panel, respectively.

Trends in raw-material supply

The development of China's plywood production can be divided into three different eras of raw material sourcing.

- 1949-1980: Domestically produced logs were the principal raw material. They were mainly large-sized logs from natural *Tilia, Fraxinus manchurica* and *Betula* forests in northeast China. Industrial development was stagnant and production was less than 1 million m^3.
- 1981-2000: Imported wood, mostly the *Eucalyptus saligna* from Indonesia and Malaysia, was used as raw material. High-quality, broadleaved hardwoods from domestic sources were in short supply in the early 1990s, so a large amount of plywood made of tropical species was imported. Concurrently, imported wood was also being used, and foreign investment in Chinese plywood production started to build momentum.
- 2001-present: Poplar is used for core veneer, and imported wood is used only for face veneer. Imports come mainly from Africa rather than Southeast Asia, as was previously the case. The development of China's plywood industry started to accelerate during this period. Processing technologies and equipment were gradually upgraded, and the quality of plywood was improved. Moreover, production costs were low, meaning that plywood production not only met the needs of the domestic market but was also exported in large quantities owing to its price competitiveness.

Results of the survey carried out among enterprises indicate that the supply of raw material is currently sufficient; some larger-sized plywood enterprises have established their own plantations as raw material production bases to ensure that this is the case. A few enterprises indicated that the supply of raw material was low – particularly of tropical wood – and that the price was rising. Plywood is a resource-dependent sector, and with the rapid increase in China's capacity to produce plywood, it is expected that shortage of raw material could become one of the limiting factors.

Supply

The future supply of raw materials for China's plywood industry is likely to come from various sources:

Plantations

Before the implementation of the natural forest protection programme in 1998, 80 percent of wood came from natural forests. However, since then wood production from natural forests has decreased sharply. In 2011 protection of natural forests was further strengthened, and since April 2014 commercial harvesting of natural forests in Heilongjiang province (a key state-owned forest region) stopped, as these forests were set aside for restoration. The supply of wood from China's natural forests is being replaced by plantation-sourced logs.

The State Forestry Administration (SFA) is concentrating on creating more plantations. In 2012, it initiated a national plan to develop a strategic wood reserve (2013-2020) through the establishment of 18 plantation sites totalling 1.4 million ha distributed across six major regions and 25 provinces by 2020. Efforts will be made to grow plantations of desirable, large-diameter species using state-of-the-art science and management. When the strategic wood reserves reach the target maturity for rotation, the domestic harvest of wood is expected to increase by 95 million m^3 per year, which is expected to supply most of the raw materials needed for plywood production.

Tropical wood for high quality plywood will continue to be sourced from international market

At present, tropical wood produced in China is almost all from plantations. They are generally small in diameter, limited to just some species. The country has tried to establish production bases for species of large-diameter tropical hardwood, but these do not supply enough wood to meet demand. Raw material for making high-quality plywood will continue to be sourced from the international market.

By establishing a sustainable supply of tropical wood for plywood production from overseas

Since 1989, in response to the policy of going overseas, some Chinese enterprises have implemented a series of programmes to procure forest resources from countries such as Brazil, and others in Southeast Asia and Africa. At present, the government encourages enterprises to establish overseas long-term sources of tropical wood. Some enterprises have already established joint-venture plantations of teak, rosewood and other desirable tropical species in neighbouring countries that have rich forest resources, for example Laos, Myanmar and Thailand. Increasing investment from Chinese plywood companies in tropical, precious trees will provide a source of sustainable high-quality materials for plywood production in China.

Survey of plywood industries

Overview

Since the inception of the project in June 2013, the project team has been in contact with the relevant agencies to conduct a survey using a questionnaire drafted by the team from the Chinese Academy of Forestry (CAF) and revised by experts from FAO and ITTO. At the same time consultations have been made with domestic experts, provincial statistics staff and representatives of the plywood companies to provide explanations and revisions to the questionnaires.

Through coordination with the State Test Center for Wood-based Panel, 282 questionnaires were completed in combination with its test and research activities, and 26 were done through on-site investigation by the project team. A total of 308 completed questionnaires were collected, and a preliminary analysis of the responses is given below.

Distribution of participating companies

Of all 21 Chinese provinces, more than 60 percent of the companies that participated in the survey were from Zhejiang, Guangxi, Shandong, Jiangsu and Guangdong (see Figures 4.7 and 4.8).

Figure 4.7: Number of participating enterprises by province

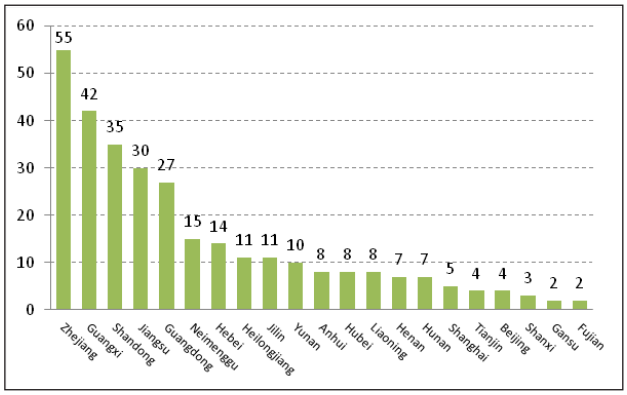
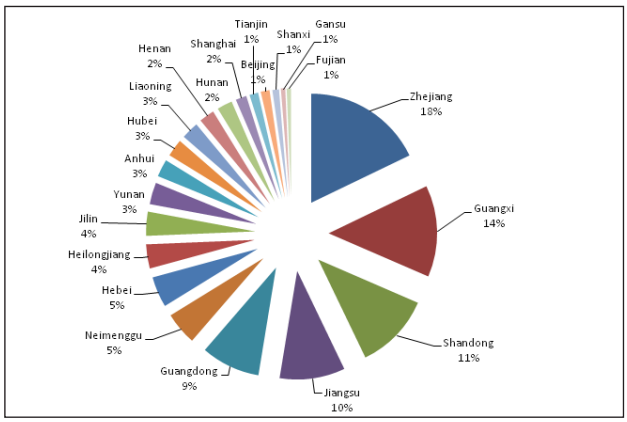


Figure 4.8: Percentage of participating enterprises in different provinces



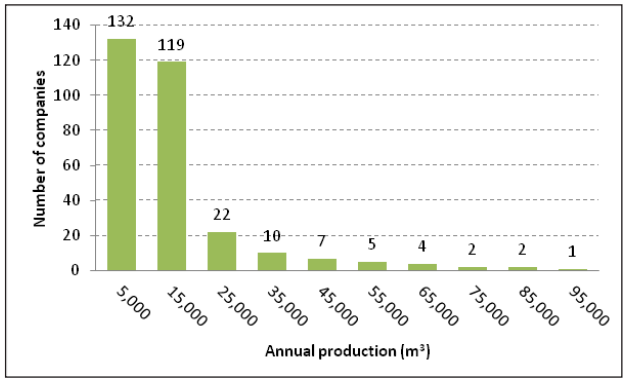
Production volume

Among the 308 plywood producers, Jiangsu province produced the greatest volume, followed by Zhejiang, Guangdong, Shandong, Guangxi and Anhui (see Table 4.4 and Figure 4.9). In addition, product specialization has become increasingly popular in the plywood clusters in China. Only a few enterprises have a complete processing chain from log to plywood.

Table 4.4: Production of surveyed enterprises by province

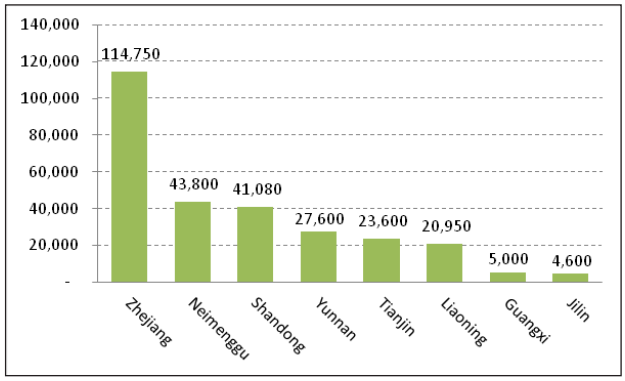
Provinces	Total production (m^3)	Average production (m^3)
Jiangsu	1,360,400	45,347
Zhejiang	342,485	6,227
Guangdong	321,800	11,919
Shandong	315,355	9,010
Guangxi	306,200	7,290
Anhui	148,000	18,500
Hebei	90,600	6,471
Henan	87,600	12,514
Heilongjiang	87,500	7,955
Hunan	79,700	11,386
Shanghai	78,100	15,620
Hubei	71,100	8,888
Jilin	59,700	5,427
Yunan	56,180	5,618
Neimenggu	50,100	3,340
Liaoning	33,800	4,225
Gansu	25,000	12,500
Tianjin	21,300	5,325
Beijing	17,730	4,433
Fujian	8,000	4,000
Shanxi	6,900	2,300

Figure 4.9: Number of investigated enterprises by level of production



Among the surveyed enterprises, 21 sold blockboard, with the greatest volumes produced in Inner Mongolia, Shandong and Zhejiang. The annual production of blockboard in different provinces is shown in Figure 4.10.

Figure 4.10: Blockboard production by province (m^3)



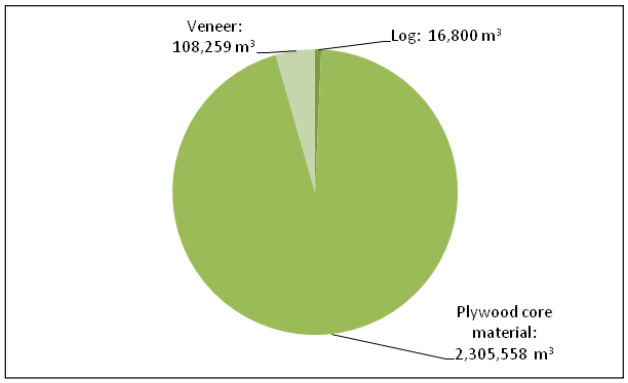
Raw materials

The questionnaire responses indicate to what extent companies use various kinds of materials (Table 4.5). Among those surveyed, 14 companies used logs, and 163 and 147 used the core veneer of plywood and veneer respectively. None used sawlogs. The volume of each type of raw material used is shown in Figure 4.11.

Table 4.5 Raw materials used by producers

Raw materials	Number of companies	Percentage
Coniferous timber	10	3.3%
Non-coniferous timber, of which is tropical timber	142	46.1%
	27	8.8%
Mixed timber	152	49.4%

Figure 4.11: Volume of materials used by manufacturers (m^3)



Only one company (Zhejiang Desheng Wood) was using imported wood, 58 percent of which were tropical species. All other enterprises were using domestically produced wood, and most were using poplar and eucalypt as raw material. Only one (Puer Linda Wood) was using solely coniferous wood. Some manufacturers were also using birch.

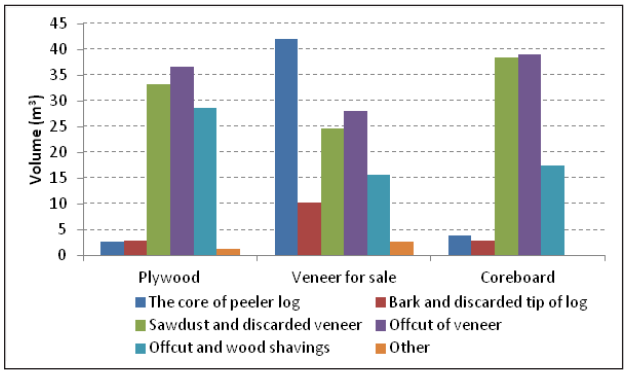
At the time of the survey, the participating enterprises were unaware of the ownership and exact origin of the raw materials and had no records. Therefore, such data were obtained through consultation with experts and literature reviews. Poplar wood came from Shandong, north Jiangsu, Henan and Hebei provinces, mostly from owned forests and some from state forest farms. Eucalypt wood came from Guangxi and Guangdong, mainly from company forests, state forest farms and collective-owned forests. Birch wood was partly from state-owned forests in northeast China and partly from Russia. Chinese Fir (*Cunninghamia lanceolata*) was mainly from the collectively owned forests in Fujian and Jiangxi provinces.

Among the surveyed enterprises, 14 had log-processing businesses. The largest average diameter of logs for plywood and veneer was 44.2 cm and the smallest was 14 cm. The longest was 9.44 m on average and the shortest was 5.79 m. Thirteen companies said the peeler core (residual part of the log after the veneer has been removed) had an average length and diameter of 1.95 m and 3.56 cm respectively.

By-products and residues of processing

The by-products of production and the residues of processing were mainly log cores, bark, cull logs, sawdust, broken and

Figure 4.12: Average volume of by-products and residues during production of plywood, veneer and blockboard (m^3)



waste veneer, waste from trimming and other processing residues. The average volume of by-products and processing residues produced during the production of plywood, veneer for sale and blockboard are shown in Figure 4.12. The main by-products and processing residues from plywood production were offcuts of veneer, sawdust and discarded veneer. The main by-products and processing residues from veneer production were the core of peeler log and offcut of veneer. The main by-products and processing residues from veneer production were offcut of veneer, sawdust and discarded veneer.

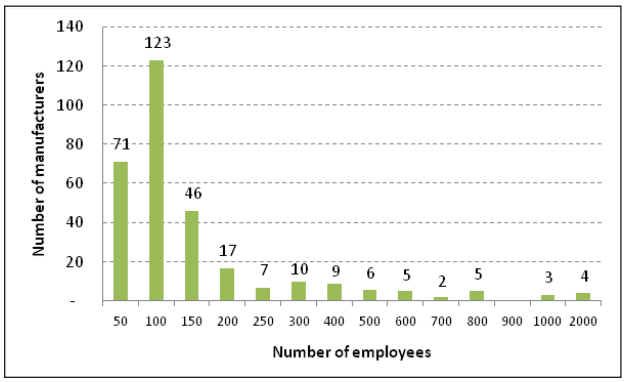
End uses of by-products and residues of processing

According to the results of the questionnaire, more than 65 percent of the by-products and residues were used for particleboard and fibreboard, about 20 percent for fuel and 15 percent for other purposes.

Size of the enterprises

The average number of employees in each mill was 161. Six enterprises had more than 1 000, and the largest number of employees was 2 000 (see Figure 4.13).

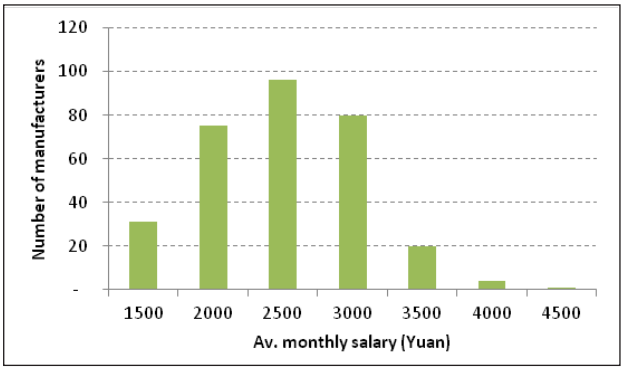
Figure 4.13: Number of staff employed in different enterprises



Staff salaries

The average staff salary was 2 337 CNY per month, varying from 1 200 yuan/month to 4 500 yuan/month, depending on the type of work. From interviews with employees, the salaries of technical workers at plywood factories were all above 3 000 yuan/month (see Figure 4.14). Moreover, these employees worked on average 9.89 hours per day. This is not consistent with the labour law of the Peoples' Republic of China, which stipulates eight hours as the maximum length of a working day. The questionnaires also indicated that employees worked an average of 320 days per year.

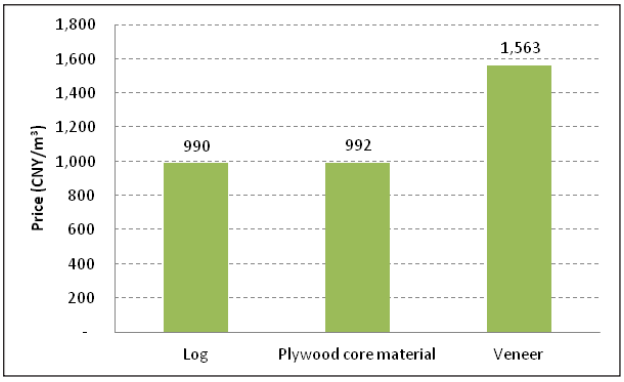
Figure 4.14: Average monthly salaries



Price of materials purchased

The survey showed that the average purchasing price of roundwood was 990 CNY per m^3. The main tree species included poplar, eucalypts and birch. The average purchasing price of coreboard used to produce blockboard was 992 CNY per m^3. The average purchasing price of veneer was 1 563 CNY per m^3, made of poplar and eucalypts (see Figure 4.15).

Figure 4.15: Average price of wood raw materials used in plywood mills (CNY/m^3)



Wood conversion rate of China's plywood products

Of the questionnaire respondents, fourteen companies converted logs to plywood. Tree species involved were mainly poplars and eucalyptus. The wood conversion rate of poplar and eucalypt plywood products are shown in tables 4.6-4.8.

Plywood manufacturers use small amounts of other species besides poplar and eucalypts. It is difficult to determine the conversion rate of other species of timber. In addition, given that the survey sample comprised just 14 companies, the results are for reference only.

Table 4.6 Wood conversion rate of poplar and eucalypt plywood

Type	Tree species	Volume of wood raw materials used to produce 1 m^3 of plywood (m^3)	Conversion rate
Temperate hardwood	poplar	1.5	0.67
Tropical hardwood	eucalypt	1.48	0.68
Average		1.48	0.68

Table 4.7 Wood conversion rate of poplar and eucalypt veneer

Type	Tree species	Volume of wood raw materials used to produce 1 m^3 of veneer (m^3)	Conversion rate
Temperate hardwood	poplar	1.49	0.67
Tropical hardwood	eucalypt	1.72	0.58
Average			0.63

Table 4.8 Wood conversion rate of poplar and eucalypt blockboard

Type	Tree species	Volume of wood raw materials used to produce 1 m^3 of blockboard (m^3)	Conversion rate
Tropical hardwood	eucalypt	1.17	0.85

Other findings

For the questions that required a written reply, the responses are summarized below.

- During the past five years the prices of logs, core veneer and face veneer have increased, putting profitability pressure on the plywood producers.
- Restrictions on export markets for plywood are growing, with many enterprises exploring opportunities in the domestic market.
- Plywood for furniture and other higher value-added products have greater profitability.
- The market demand for high value-added and environmentally friendly plywood products has been increasing during the past five years.
- Enterprises currently have more contact with government agencies including the local forestry bureau, local industrial and commercial agencies, taxation agencies and customs (only for export enterprises), but less contact with statistical agencies.

Enterprises hoped to have face-to-face meetings with the statistical agency staff to understand fully the meaning of some statistical indicators. Usually the statistical agency sent statistical tables to the enterprises and required them to fill in and submit the tables within a given timeframe. Therefore, the respondents requested better training for local statistical agencies to improve the accuracy and consistency of statistical data.

End uses of plywood and its by-products

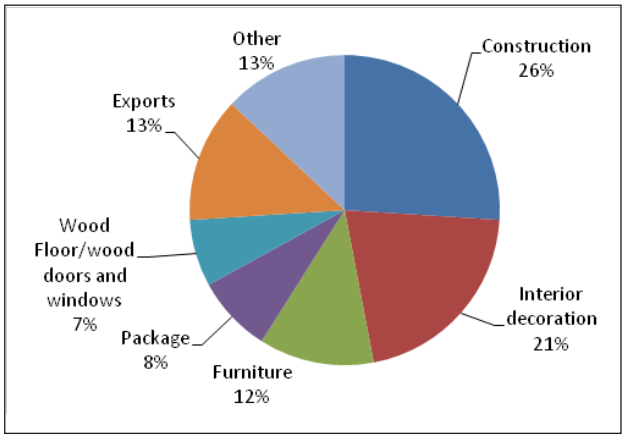
End uses of plywood

In the 1980s about 70 percent of plywood was used in furniture; 15-20 percent in construction, doors and windows; 2-3 percent in vehicles and ships; and 7-13 percent for other purposes (including packaging). In the 1990s plywood consumption patterns in China changed; for example, in 1995, 49.9 percent was used for furniture, 29.5 percent for

Table 4.9. Wood conversion rate of China's plywood product in surveyed enterprises													
Enterprises	**Provinces**	**Plywood** (from veneer to plywood)				**Veneer** (from log to veneer)				**Blockboard** (from sawnwood to blockboard)			
		Average	Poplar	Eucalypt	Other	Average	Poplar	Eucalypt	Other	Average	Poplar	Eucalypt	Other
Zhejiang Gangsheng Wood Co	Zhejiang								1.2				
Puer Linda Wood Co	Yunnan	1.25				1.45						1.17	
Meiya Global Wood Co (Foshan city)	Guangdong	1.54	1.52	1.5									
Xuzhou Huake Wood Co	Jiangsu	1.54	1.51	1.52									
Xuzhou Lifeng Wood Co	Jiangsu			1.3	1.2								
Xuzhou Fuer Wood company	Jiangsu			1.43				1.78	1.65				
Hangzhou Fulilai Decoration	Zhejiang	1.45	1.42	1.46		1.52	1.49	1.54					
Jiashan Dalin Wood Co	Zhejiang							1.83	1.35				
Nanning Jiangtao Wood Co	Guangxi	1.5	1.52	1.54									
Hefei Yusen Wood Co	Anhui	1.5	1.5	1.53									
Xuwen Hengdong Plywood	Guangdong	1.54	1.53	1.5									
Xuzhou Fushen Wood Co	Jiangsu	1.52	1.5	1.53									
Nanjing Meishan Wood Co	Guangxi	1.5											
Xuzhou Weilin Wood Co	Jiangsu					1.09							

construction, 10 percent for packing, 4 percent for transport and 5.6 percent for other purposes (Huang 2013). Entering the twenty-first century, China's rapid growth in construction, increases in the furniture producing industry and other demands led to heightened use of plywood – particularly overlaid plywood, which has become the current favourite in interior decorating. This is made through overlaying a sheet of veneer on to the plywood. Usually the veneer is made of hardwood with a high-quality grain, but the plywood is made of poplar or eucalypts. Consumption patterns further changed in 2012, according to the available information (Huang 2013; see Figure 4.16).

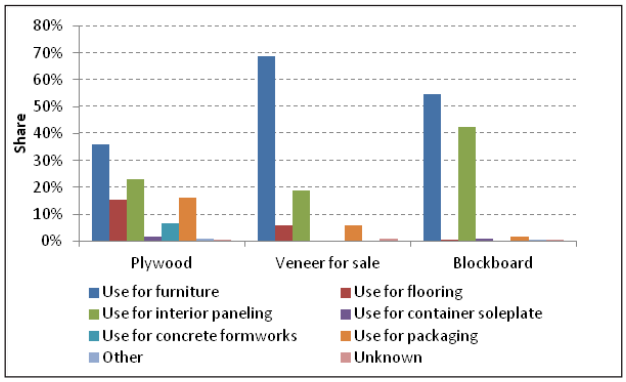
Figure 4.16: End uses of plywood



The changes in end-uses of plywood can be attributed to the significant evolution of the composition of plywood products, in the properties of plywood products and new areas of application due to improved functions of plywood, e.g. flooring, decorating and construction.

According to the results of the survey, the end uses of plywood, veneer for export and blockboard were mainly furniture, flooring and internal panelling (see Figure 4.17).

Figure 4.17: End uses of different plywood products

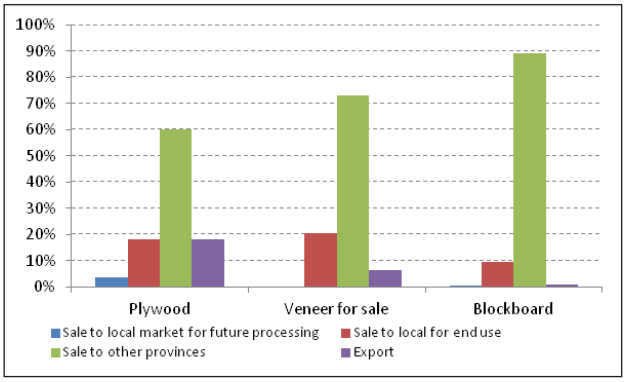


Distribution channels of plywood and its by-products in China

The flow of plywood

As mentioned previously, wooden furniture is the most common use for plywood, followed by interior decoration panels. The survey results indicate that there were four main buyers of panels and

Figure 4.18: Percentage of flows of different plywood products in surveyed enterprises



veneer: the local market for further processing; local markets for end use; and other provinces. Sales of plywood to other provinces accounted for 60 percent, export for 18 percent, local markets for end use for 19 percent and local markets for further processing for 3 percent. Sales of veneers for export to other provinces accounted for 73 percent of the total, and sales to local markets for end use accounted for 21 percent. Sales of blockboard to other provinces accounted for 89 percent and sales to local markets for end use accounted for 10 percent (see Figure 4.18).

Buyers of by-products and residues

By-products and residues of the mills were mainly used for own consumption and sold to local markets; little was sold to other regions.

Future development trends

Generally, the plywood sector in China has the following characteristics:

- Low-cost labour. Although labour rates have been facing upward pressure, costs are still advantageous compared with other advanced countries.
- Veneer is naturally dried using solar energy, so it is difficult to get plywood dry enough for quality lamination of panels without using a dryer.
- High recovery rate. In some regions, such as Shandong, the recovery from logs to plywood can be as high as 80 percent or more.
- The plywood industry has become a driving force for enhanced plantation development.

The plywood industry is developing rapidly in China – the sector has grown by an average of more than 20 percent a year since 2008. However, with rapid development the plywood sector also faces many challenges. For example, it is undeniable that China's plywood sector faces some serious problems in terms of quality and low added-value. The future development of the sector requires that the government, science and technology agencies, and industrial associations strengthen the subsectors within the industry clusters through guidance and planning.

Specifically, future developments in the sector will be concentrated in four areas.

- Continual improvement in regulations of entry into the plywood industry. In the future, regulations of entry to the industry will be based on not only on economies of scale but also on quality of the products. It will provide support to high-end enterprises through industry associations and quality control agencies in the form of technical training, participation from science and technology agencies, provision of financial assistance, and establishing a credit and a quality control system.
- The effects of industrial clustering will become even more significant and regional economic advantage more prominent.
- Assistance to the development of leading enterprises, which will integrate the small and medium-sized enterprises through mergers and acquisitions; upgrading and improvement of equipment; export management; improvement of overall product quality and environmental friendliness.
- Increased use of plywood. As the construction industry grows in China, the demands for plywood for structural uses will increase every year. Plywood for concrete formation will also be developed. Moreover, modern houses with wooden structures that are common in many countries have grown in popularity in Shanghai, Beijing, Nanjing and Suzhou.

Direction and suggestions for future studies

According to State Forestry Administration (SFA) 2015 statistics, the total production of wood-based panels that year was 286.8 million m^3, of which plywood constituted 165.5 million m^3 and blockboard 20.8 million m^3 (see Table 4.10).

Table 4.10 Production of wood based panels in China, 2012-2015 (million m^3)

	2012	2013	2014	2015
Total	**223.4**	**255.6**	**273.7**	**286.8**
Plywood	109.8	**137.3**	149.7	165.5
Fibreboard	58	**64**	64.6	66.2
Particleboard	23.4	**18.8**	20.9	20.3
Other	32.1	**35.5**	38.5	34.8
Of which blockboard	18.7	**21.2**	23.9	20.8

Source: SFA, 2015.

China's wood-based panel industry is still developing rapidly. Improvement of the statistical data will assist policies on wood-based panels. Thus, it is necessary to continue improving the statistical data on wood-based panels. Based on the experiences of the current survey, directions for future studies are proposed.

Suggestions for improvement

1) Capacity-building projects for statistics staff

During the survey, it became apparent that the statistics staff of local forestry agencies did not always have the required training and technical skills, which often led to incomplete data of poor quality. Therefore, targeted training and technical exchanges for the statistics staff is recommended, including access to data standards, statistical analysis and data checking.

2) In-depth analysis of the plywood industrial chain

China has a complex plywood business chain that involves foresters, wood dealers, transporters, producers, wholesalers, retailers and secondary manufacturers. As this makes it difficult to accurately access complete and accurate data, on-site investigations focusing on the entire industry chain and analysing critical check points should be conducted in the cluster regions.

3) Studies on national and international statistical standards for forest products

In China, the statistical classification of some forest products is not harmonized across agencies. In the case of wood flooring, the classification system of the State Statistics Bureau is too ambiguous, is not aligned with the international system and poses difficulty in getting statistical data from enterprises. Adjustment and improvement is needed in the current system to improve the accuracy of statistics and provide consistency with international statistics.

4) Continued case studies on wood-floor production

It was found during the survey that neither the State Statistics Bureau nor the SFA had any production indicators for intermediate products for flooring products in the statistical classification. These refer to the wooden base used for producing laminated flooring. Intermediate products for flooring and finished flooring products are generally not produced by the same enterprise; the former are produced by separate enterprises upstream. Because there were no statistical indicators for semi-finished flooring products (flooring billets), the producers of the latter counted the production as the finished wood flooring product, which resulted in the duplication of calculation data on semi-finished flooring. This problem applies to solid wood flooring and composite wood flooring. For this reason, it is suggested that a case study on statistics of wood floors be carried out to assess the extent and weights of repeated statistical data.

5) Survey a sample of enterprises that are below the designated scale

The survey found that statistical capacity was weak and business managers lacked awareness in this area. The result was that no statistical data were available for enterprises below the designated scale (enterprises were not included in the statistics if production was below the cut-off point), which led to missing data on some forest products. Forestry agencies had no direct administrative relationship with private wood products businesses, and in some cases enterprises failed to cooperate. Most plywood enterprises in China are below the designated scale for reporting; therefore, it is suggested that a stratified sampling be carried out on these enterprises to obtain data for the revision of the current statistical data.

6) Carry out studies on trade flows of plywood

Knowledge on the trade flows of the plywood industry is important to improve the statistics and provide policy recommendations. Studies could be carried out covering sources of logs, for example Africa, New Zealand, North America and the Russian Federation.