Current status and system construction of used-furniture recycling in China

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Abstract
To promote the development of the green and low-carbon wood industry and explore the current status and trend of China’s used-furniture recycling, this paper summarizes the research status of used-furniture recycling and interprets governmental strategies, such as the development of used-furniture recycling system, the way of handling used-furniture by manufacturers, and the attitudes of customers towards used-furniture, through extensive literature reviews and market research. From such three respects as government, furniture manufacturers, and consumers, the problems of national used-furniture recycling are analyzed, for example, imperfect system, high cost, and weak awareness. Therefore, to solve the above issues, it is necessary to construct national used-furniture recycling system and methods. The government should pay attention to the construction of recycling network, the supervision and support of entrepreneurial responsibilities, and the formulation of recycling standards. For furniture manufacturers, the improvement of the durability and recyclability of furniture and the development of new models and new technologies for furniture recycling and transportation are their primary assignment. And for consumers, the improvements of their concepts of consuming and the environmental protection are in focus. In sum, it aims to provide both suggestions for the amelioration of the measures and methods, and support for the understanding of the change, of used-furniture recycling in China.

Keywords Used-furniture · Recycling · Recycling status · System construction

Low-carbon economy is currently one of the quantifiable sustainable economic development models. It is through various methods such as technological innovation, institutional innovation, industrial transformation, and new energy development that can reduce resource consumption and greenhouse gas emissions as much as possible (Zhao 2020; Li 2019). With the elevation of living standards, the speed of furniture replacement is accelerated as well (Mao and Wu 2016). According to the research, the storage of wood resources in China continues to decline every year (Li et al. 2017). The used-furniture produced in China is about 6000 tons each year, approximately 85 million m³ (Wang et al. 2020). However, the shortage of resources and severe waste restrains the sustainable development of the furniture industry, so it is of imminence to solve the problem. If used-furniture is classified as domestic waste and disposed by incineration or landfill, the wood material contained in used-furniture will emit a large amount of carbon dioxide and toxic gases after combustion. For the time being, if buried in the soil, the furniture hardware will also induce metal pollution. That is to say improper handling will do harm to human health and their living environment a lot. Thus, the used-furniture recycling can not only alleviate the shortage of wood resources and serious waste effectively (Eisenlauer et al. 2018) but also promote the sustainable development of the furniture industry and achieve a win–win situation between environmental protection and economic development (Yang et al. 2019), which is of great significance in stimulating the development of the green and low-carbon wood industry.
To promote the recycling of used-furniture, a large number of actions have been taken at home and abroad for a quite long time. Owing to the economic, ecological, legislative, and many other circumstances, developed countries have long stipulated that waste wood materials should be reused as secondary raw materials (Ravi et al. 2005). In 1990, the USA and France launched policies for the recycling of wood waste materials, requiring that the recovery rate of the major categories of wood materials must reach 80% (Wu et al. 2016). In March 2003, Germany promulgated the “Waste Wood Management Act” to prohibit the random landfill of waste wood and vigorously develop the technology of making wood-based panels out of waste wood (Hu and Xiang 2006). Japan has issued relevant laws and regulations that the minimum recycling rate of waste wood should be 98% before 2010. Concurrently, developed countries have established a complete recycling system for used-furniture (Wang et al. 2019).

Compared with developed countries, measures for used-furniture recycling in China are still in infancy (Mao et al. 2019). In 2005, the National Development and Reform Commission in the “Opinions on Accelerating Wood Conservation and Substitution” clearly pointed out the unmatched condition of current timber conservation and reuse work with the developmental requirements of economy and society, the low rationality of timber consumption behavior and consumption structure and, as well, a gap in the level of production, processing, protection, and recycling of developed countries. As a result, relevant departments in China proposed to formulate the “Management Code for Discarded Wooden Recycling and Utilization (GB/T 22,529—2008),” “Classification of Discarded Wooden Materials (GB/T29408—2012),” “Test Methods of Recycled Wood for Wood-based Panel Manufacture (LY/T 2558—2015),” “Quality Requirements of Recycled Wood for Wood-based Panel Manufacture (GB /T 33,039—2016),” “Code for Recycling Utilization of Waste Wood (LY/T 1822—2019),” and other related standards (Zhang et al. 2021), which regulated and guided corresponding enterprises and consumers to recycle and reuse waste wood materials, so as to initially build a recycling system for waste wood materials. Nonetheless, since there is larger amount of waste furniture in China per year than the traditional wood materials and great regional differences in the disposal methods of waste furniture, no effective and mature recycling system of used-furniture is taken shape across the country (Xu et al. 2022).

Based on an extensive relevant literature and market research, there have been informative reviews that summarizes the current circumstance and expounds the existing problems of used-furniture recycling in China. In light of this problem, the perspectives of the government, furniture manufacturers, and consumers are considered the key points in the process to form a system for used-furniture recycling and feasible solutions in China, aiming to provide reference for the development and improvement of used-furniture recycling systems at home and abroad.

**Literature review on the status of used-furniture recycling**

**Spatial distribution of theme research**

From the 1990s, the recycling of used-furniture is of a long history internationally. Therefore, compared with domestic research systems in this field, some developed countries have more complete theoretical ones. Accordingly, the author in order to visualize more efforts made by various countries in recycling used-furniture in the globe, the author conducted a visual map analysis of the published papers in this field through the Cite Space software (Chen 2017). The search database is Web of science, and the core keywords are used-furniture and furniture recycling. The 443 documents after the limited search were processed and analyzed. Different nodes represent the different publication situations in varied countries, and the number of branches between represents the cooperative relationship of different countries, as shown in Table 1 and Fig. 1.

| Quantity | Country | Centrality | Quantity | Country | Centrality | Quantity | Country | Centrality |
|----------|---------|------------|----------|---------|------------|----------|---------|------------|
| 60       | China   | 11         | 16       | Malaysia| 11         | 6        | Canada  | 3          |
| 50       | USA     | 13         | 12       | Romania | 3          | 6        | Taiwan  | 6          |
| 41       | Brazil  | 7          | 9        | Portugal | 4         | 5        | Germany | 4          |
| 35       | Spain   | 12         | 8        | Czech Republic | 7         | 5        | Finland | 5          |
| 30       | Poland  | 4          | 8        | Slovakia | 5         | 5        | Austria | 7          |
| 27       | Turkey  | 2          | 8        | Japan    | 2         | 5        | Bangladesh | 5         |
| 22       | India   | 7          | 7        | Colombia | 5         | 5        | Bangladesh | 7         |
| 20       | Italy   | 7          | 7        | Australia | 4         | 4        | Switzerland | 4         |
| 19       | France  | 13         | 6        | South Korea | 4        |          |          |            |
| 18       | England | 11         | 6        | Egypt    | 4          |          |          |            |
In Table 1, the related research on the recycling of used-furniture involves 27 countries, with the largest number of 60 articles published in China, which are relevant to the high importance attached to the concept of recycling and green development in recent years. The USA and Brazil are ranked second and third respectively, with 50 and 41 articles published, showing that developed countries pay close attention to used-furniture and furniture recycling (Ciupan et al. 2018). In terms of centrality, the highest one is France where the cluster project is the research on “waste-derived low-cost mycelium” (Abbas et al. 2015). The second is the USA, where the cluster project is a research about “aluminum production waste.” Spain is in the third, and the cluster project is “Waste Furniture” (Remen Lin et al. 2020). Meanwhile, according to the literature content, the research mainly focuses on the reasons for the abandonment of wooden furniture (Wu et al. 2016), the implementation of recycling measures (Liao 2018), the feasibility of the recycling of used wooden furniture (Krystofik et al. 2018), technology development for the efficiency of wood resource utilization (Xu and Zhu 2019), and the environmental impact of used wood furniture recycling (de Oliveira 2018).

As is shown in Fig. 1, the connection among countries is very intimate on this research topic, illustrating the close cooperation between countries in the field of used-furniture recycling. In addition, although the USA, France, and Spain are not the same good as China in the number of published papers, they have higher centrality and cooperation density, which is of great inspiration for China to prompt the used-furniture recycling in the future international cooperation.

**Recycling methods**

Based on the relevant literature review and research, it is clear that foreign countries are also better than domestic ones in the market operation and treatment of used-furniture recycling. For example, most cities in Germany currently set up “urban waste-management companies” by adopting the form of “reservation for door-to-door recycling” and “free door-to-door recycling,” which has increased the popularity of used-furniture recycling to a certain extent. For example, the Italian MzuroSaviola wood-based panel production plant used waste wood to make particleboard, and then reapplied it to such decorative materials as wooden floors and skirtings. Australia also actively promoted the recycling of used-furniture through various forms (like “garage sales” and “big-ticket disposal days”). IKEA in Sweden launched a paid furniture recycling program and second-hand furniture resale activities and Brazil adopted the strategic guidelines of the circular economy to determine the way and direct the final destination for the production and recycling of industrial furniture products for the enterprise cluster. At last, Japan issued corresponding laws and policies on wood recycling, furniture service life, and utilization rate, and most cities are covered by the sites of government-commissioned bulky waste disposal or private waste collection.
In China, since the beginning of the twenty-first century, the government in Taiwan has vigorously promoted waste resource recycling programs and gradually realized the process of industrial products from cradle to cradle (C2C) (Remen Lin et al. 2020). Beijing took the lead in the pilot work of replacing old furniture with new ones, and Shenzhen established a used-furniture collection and transportation system within its jurisdiction so as to promote the resource utilization. Cities like Changsha and Shangrao established wood recycling stations (Yu and Lv 2021), as well as Guangdong and Anhui conducted used-wood furniture and professional research work on its recycling. Furthermore, some furniture companies have also launched corresponding plans, such as the launch of the door-to-door recycling business of used mattresses by Red Star Macalline, the establishment of a large-scale used-furniture recycling center by Easyhome, and the like.

In the past two decades, though many national efforts have been made in the recycling of used-furniture through government and furniture enterprises, China, as a major furniture producer and consumer in the world, still lags behind that of developed countries in used-furniture recycling (Min et al. 2004). It is also of necessity, while imitating the methods of developed countries, to consider about the reality in China to build a used-furniture recycling system from the aspects of policy formulation by government, design, and production of furniture enterprise, and environmental protection awareness in consumers.

Existing problems in the recycling of used-furniture in China

Incomplete recycling system of used-furniture

Under the background of the low-carbon economy and sustainable development strategies proposed by the Chinese government, some regions began to set up measures and methods for recycling used-furniture. For example, in April 2009, the “Annual Report on Development of Changsha-Zhuzhou-Xiangtan City Cluster” mentioned that Hunan Province was less effective in the comprehensive utilization of agricultural and forestry resources, resulting in introducing a policy of exempting value-added tax for used-recycling business units to promote the recycling and utilization of renewable resources, and meanwhile, encourage and reward the development of reengineering industry and technological innovation. In 2012, Beijing promulgated the “2012 Beijing Furniture Trade-in Pilot Implementation Measures,” which cannot be widely popularized due to cumbersome procedures but only for users who would purchase new furniture. Then in 2018, at the requirement of the government, Beijing piloted the whole process of four links of used-furniture, delivery, recycling, transportation, and processing in Haidian District, and issued subsidies to enterprises to utilize the recycled waste wood and sponge as the fuel for thermal power generation. It has at present achieved the annual recycling of about 500 tons of steel scrap, 2000 tons of wood scrap and 70 tons of sponge scrap. In July 2021, Shenzhen drafted the local standard “Specifications for Recycling and Comprehensive Utilization of Waste Furniture,” to regulate the definition, collection and temporary storage, transportation, and comprehensive utilization requirements of used-furniture to improve the recycling rate of domestic waste in Shenzhen. However, there is still no city in China that has the ability to form a comprehensive coverage of recycling guarantee measures, especially for used-furniture recycling. Environmentally friendly enterprises and traditional recycling institutions are still the essential parts that are short of system concepts and innovative policies. How to reuse is still a weak link in used-furniture recycling system, which requires the joint efforts of government leaders, furniture companies, and consumers.

High cost of used-furniture recycling

The recycling of used-furniture should take recycling methods, secondary repairs, and reuse methods into consideration. However, in processing used-furniture, there are often such shortcomings as low level of recycling technology, low recycling rate, and high recycling costs, resulting in high investment and low sustainability in furniture manufacturing enterprises (Zhu et al. 2022a). After repairing the surface of some high-grade waste solid wood furniture, or processing it into new furniture, it can still be normally used in the market (Han and Gao 2019). For example, there are tens of thousands of high-grade used-furniture recycling merchants on an e-commerce platform. Being accumulated till November 2021, there are as many as 31,689 high-grade used-furniture recycling merchants in Nanjing on the 58.com platform alone owing to the high added value of high-grade used-furniture, which attracts enterprises and individuals to recycle it (Bin et al. 2012). However, for ordinary used-furniture with lower value, only a small part can be recycled. Since used solid wood furniture can be used to process wood panels and integrated into timber, the complete parts are able to be made as stress-supporting parts of tables, chairs, or lamps (Ly and Huang 2016) with high practical value. The used panel furniture is often merely applied to produce raw materials such as particleboard, fiberboard, and wood-plastic composite materials. When it is reused, the investment cost is often very high. For example, Zhejiang Liren Group has cooperated with Shanghai Environmental Sanitation System to recycle waste wood resources in Shanghai and utilize it to produce environmentally friendly wood-based panels (processing about 100,000 tons of wood waste in Shanghai every year), of which the annual output is about 150,000 tons (Li et al. 2017). In
terms of the current financial strength and technical level of Chinese furniture manufacturing enterprises, it is still no simple to reach the scale of Liren (Zhu et al. 2022b). As a consequence, the current Chinese furniture enterprises are generally less enthusiastic about the recycling of waste furniture and still unable to share the main tasks in the used-furniture recycling system. So to speak, the government urgently needs guidance and relevant policy preferences.

**Weak awareness towards used-furniture recycling**

Consumers have dual identities in the recycling system. On the one hand, their use of furniture products has resulted in a large number of scrapped resources. On the other hand, they have created a large market space for resource reuse (Xiong and Yue 2022). The main object of waste furniture recycling is still residents. At present, there are mainly three ways for residents to deal with used-furniture in China, that is, to be transferred to others, sold at a low price, and treated as garbage. For the first two ways, it is often carried out on the premise that the furniture is fully functional. Nevertheless, with the improvement of people’s living standards and the improvement of esthetic awareness, the amount of used-furniture processed in these two cases is actually limited. Due to the lack of consumptive concept and awareness of saving wood resources, the majority of consumers regard used-furniture as garbage. Moreover, the used-furniture is discarded directly as domestic waste, which not only dissipates a large amount of wood resources but also causes transportation and disposal problems for urban sanitation systems. For this reason, how to properly guide consumers to properly treat used-furniture is also a top priority.

**Suggestions on the construction of China’s used-furniture recycling system**

**Overall framework**

In view of the above problems, to effectively solve the problem between waste furniture and recycling, multi-faceted and multi-dimensional considerations are needed. The government, enterprises, and consumers should face the specific problems in the recycling process of waste furniture and put forward corresponding measures solution. First, from the government’s point of view, it should guide and support furniture manufacturing enterprises to work together to improve the recycling system of waste furniture. Second, from the perspective of furniture manufacturing enterprises, it is necessary to improve the comprehensive benefits of them from furniture durability, recyclable design, recycling mode, and new recycling technology. Third, as for consumers who are the source of waste furniture recycling (Mao and Wu 2018), it is necessary to consider the use cycle of furniture, and at the same time delay the speed of furniture replacement, establish awareness of waste furniture reuse, and correct awareness and consumption behavior of dealing with waste furniture. Therefore, this study refers to the waste furniture recycling system in foreign countries, combines with the actual situation in China, and takes solving the practical problems as the starting point to build a recycling system for waste furniture in China from three dimensions (government, furniture enterprises, and consumers), as shown in Fig. 2.

**For government**

**Build a network platform for used-furniture recycling**

For Chinese government, it is urgent to build a complete logistics network composed of recycling centers, sorting centers, processing centers, and recycling enterprises (Fig. 3). Used-furniture recycling belongs to the reverse logistics network which means the logistics operation covers from consumers to recycling institutions and then to processing institutions (Liu, 2012). Since reverse logistics generally have low benefits, the government needs to issue relevant policies and regulations to support their operation (Yuan et al. 2019). In the implementation process, especially in the construction of the network platform, it is essential to choose a well-known and reputable e-commerce platform.

![Fig. 2 Used-furniture recycling system in China](image-url)
Afterwards, the government or non-profit organizations will take the lead in cooperating with furniture manufacturers or other recycling enterprises. Accordingly, the joint operation of a network platform system by new enterprises can be conducted for recycling used-furniture. In the meantime, the network platform system should be of high credibility to allow direct communication between consumers and recycling companies, and effectively solve the problem of slow recycling and difficult disposal of waste furniture (Li and Yao 2021).

Supervise and support furniture manufacturing enterprises to assume responsibility for recycling

For government on considering the whole life cycle of furniture, it is necessary to make furniture manufacturers take the responsibility of recycling waste furniture. On the one hand, furniture manufacturers should track the entire life cycle of furniture and formulate corresponding regulations to supervise whether furniture manufacturers participate in the entire process from production to recycling. The recycling should be advocated by furniture manufacturers to cooperate with recycling companies or distributors. And furniture manufacturers should entrust recycling companies to deal with used-furniture and provide them with financial and technical support (Wu et al. 2022). On the other hand, for enterprises that attach importance to the development of the used-furniture recycling system, the government should give policy support to enterprises to reduce some of the financial pressure. For enterprises that have not yet developed a used-furniture recycling system, it would be better to guide them to gradually incorporate used-furniture recycling into their business operations, pay attention to the design of recyclability, and provide assistance in policy and technology (Zhang 2021).

Formulate a standard system for the recycling of waste furniture

The government is supposed to encourage universities, scientific research institutes, and enterprises to cooperate with each other, so as to actively formulate used-furniture recycling standards (Liu and Shang 2013), speed up its classification, and maximize its utilization value. In addition, the ecological environment can be effectively improved, and CO2 and harmful gas emissions can be reduced. For one thing, it can quickly identify the types, clarify the utilization methods, fully develop the utilization value and packaging materials (Lu and He 2019), and expand the application field from wood processing to the pan-home industry (Li et al. 2017). For another, for reusable furniture and packaging materials, it may as well take such issues as energy consumption, environmental hazards, and utilization efficiency in the utilizing process into consideration (Liu and Yu 2021). For used-furniture and packaging materials that cannot be reused, landscaping, soil composting, and many others are possible ways to avoid being used as fuels based on environmental protection concepts, such as “returning waste wood to forest” and “returning waste wood to soil” (Cheshmehzangi 2021).

Furniture manufacturers

Improve the durability of furniture

Improving the durability of furniture extends the life cycle of furniture, thereby delaying the time for waste furniture to enter recycling and reducing the workload of recycling companies or distributors. The improvement of the furniture durability is to extend its life, namely, the reinforcement of its damage resistance (Li 2018). In the production of furniture, it would be better to select raw materials from wood with good physical and chemical properties, corrosion resistance, and waterproof and moisture resistance (such as new wood-based panels and wood-plastic composite panels). What's more, to improve the surface strength of furniture, special treatment can be available to prevent scratches and stains. Also, such vulnerable parts of the furniture structure as the load-bearing end can be reinforced. As for solid wood furniture, a finishing treatment can prevent surface damage.

Design for furniture recyclability

Furniture recycling design cannot merely effectively solve the problems of difficult disassembly, classification, and material handling, but also prolong the life cycle of furniture.
and reduce the generation of used-furniture. The implementation process is summarized, which can be considered from the following aspects.

1) Use ecological and renewable materials. When choosing raw materials for furniture, it is important to consider materials with excellent physical and chemical properties, corrosion resistance, and waterproof and moistureproof, as well as to be green and renewable (Mao and Hou 2020). For example, fast-growing wood, bamboo, rattan, etc. that have a short growing cycle can be used as materials for the production of wood-based panels or wood composites after being discarded (He 2019). At the same time, the unity of the same furniture product materials should be ensured, and the difficulty of processing be reduced when recycling (Zhang 2019).

2) Detachable design. The detachable design of furniture is about the connection of furniture components through standardized hardware, special interfaces, or special wooden components. It can simplify the installation and disassembly process to realize the nail-free design of furniture. On the one hand, due to the standardized connection structure, the production cost can be greatly reduced, so that the enterprises have more resources for the development of used-furniture recycling. On the other hand, the detachable design reduces the damage of parts and improves the recycling rate of used-furniture. A hardware connection design from Noir Vif company is shown in Fig. 3, which can be used as a connection structure for bookshelves. By connecting the plate parts of the bookshelf with each other through hardware, they can be combined freely according to the needs of consumers. When the bookshelf is installed and disassembled, no auxiliary tools are required, saving a lot of manpower.

In addition, the detachable tenon-and-mortise structure is also a typical representative of Chinese furniture. One of the classic detachable tenon-and-mortise structures — Luban lock — is shown in Fig. 4, which utilizes the simplest concave-convex cross-bite structure (Xiong et al. 2021). Some modern detachable furniture also adopts the structure of Luban lock in structural design, using two or more parts to lock each other, as shown in Fig. 5. The parts of the furniture conform to mechanized and standardized production, and the structure has high strength and firmness.

3) Modular design. Modularity in design is a design theory and practice that subdivides a system into smaller parts called modules, which can be independently created, modified, replaced, or exchanged between different systems. Furniture with modular design delays the abandoning frequency, and the interchange between modules can effectively extend its life cycle. In the recycling of used-furniture, the simple structure design can also settle the complex furniture classification problem. Modular design cannot merely lengthen the life cycle of furniture products by making furniture products into different modules so as to be combined into various products according to the needs (Lu et al. 2016), but also diversify products through the arrangement and combination of various modules, so that they can be changed according to the needs of consumers. In turn, the life cycle of furniture is extended, and its generation to a certain extent.

Figure 6 shows the application of modular design furniture. On the left of Fig. 6 is a tangram bookshelf designed by Italian designer Daniele Lago, which contain seven creative parts through different arrangements and combinations. Different parts can also be functionally planned to meet the individual needs of modern people. On the right of Fig. 6, a BUILD modular shelving system was designed by British designers Jack Godfrey Wood and Tom Ballhatchet. The basic structure of the system is a hexagonal box, which can be used as a stool, small dining table, or tote. Three or more hexagons can be combined together by tripod pins to be used as bookshelves, partition walls, and other household items by consumers according to different combinations (Jie et al. 2022).

4) Indicate recycling information. When designing furniture, it is necessary to consider the possibility of recycling of raw materials and parts, structure and process of products, and meanwhile, indicate the relevant information on recycling in the product manual (such as the characteristics of the material, the degree of danger to
the environment, and the structure description), so as to facilitate the classification of used-furniture during recycling, and improve recycling efficiency.

**Develop a new model of furniture recycling**

It is essential to construct a used-furniture recycling model that matches the entrepreneurial strength with the ability to undertake social responsibility, save production costs, and promote profit growth (Lu et al. 2016). Concurrently, furniture manufacturers have great financial pressure in recycling used-furniture, which can be alleviated by cooperation with third-party enterprises (Long et al. 2018). Under the principle of information disclosure and resource sharing, furniture manufacturing enterprises and third-party enterprises make cooperation with each other to form an organizational alliance of used-furniture recycling. This model is beneficial for furniture manufacturing enterprises to be more flexible while maintaining the stability of enterprise funds. For example, when a furniture manufacturer conducts used-furniture recycling, it only needs to allocate a small number of staff within the company to form a recycling team with a third-party company, costs a small amount of labor to complete waste furniture recycling (Zhu et al. 2022c). During recycling, furniture manufacturers can also acquire about different product designs and quality defects in improving the process and product innovation and bringing higher benefits to the furniture manufacturers (Spicer and Johnson 2004).

**Develop new technologies for furniture recycling and transportation**

The characteristics of used-furniture are large volume and weight, different shapes, and varieties. After recycling, transportation problems restrict the efficiency and cost of recycling used-furniture by furniture manufacturers. When loading used-furniture at each recycling site, it would be better to take the demand, geographical distribution, and vehicle loading capacity of each recycling site into consideration, and keep the distance and usage of vehicles as low as possible. It is also ensured that the used-furniture in all recycling sites can be fully recycled, on which a multi-objective mathematical model is established (Pang et al. 2020). Intelligent optimization algorithms have global optimization capabilities (such as two-stage genetic algorithm (Mohammed et al. 2017), two-stage taboo search algorithm (Lai et al. 2010). The development of new intelligent optimization algorithms can effectively solve the transportation problems in the process of used-furniture recycling.

**Consumers**

**Improve the concept of consumption**

With the improvement of living standards and the pursuit of higher quality of life in China, residents have two consumptive concepts in wooden furniture. One is cheap ordinary furniture (such as panel furniture), and the other is expensive high-quality furniture (such as rosewood furniture) (Zhang 2021). At present, the style of panel furniture is updated quickly at a low price, but it is easy to be damaged in use, so residents generally discard it sooner or later. High-quality furniture is expensive, on account of which residents will protect it carefully when using. Moreover, high-quality furniture can improve the quality of life and bring a higher one, so residents will not easily regard high-quality furniture as used-furniture (Zhang et al. 2021). From the perspective of used-furniture recycling, high-quality furniture possesses higher durability, but will not become the main type of social consumptive furniture due to its high price. The consumption of high-quality furniture easily makes consumers feel competitive that invisibly increases the speed of furniture replacement. Residents are guided to develop the main concept of low and less consumption of furniture under the premise of harming no health and meeting the needs of daily life. Therefore, improving the consumptive concept of residents is conducive to reducing the generation

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**Fig. 6** Modular design furniture
of used-furniture and the pressure on society to deal with used-furniture (Ali and Daeechian 2014). Through the recycling furniture network platform, individuals can enter the information of waste furniture, such as material, age of use, quality, and physical photos (Yang and Xiong 2022). They can also choose to apply for the platform’s technicians to determine whether the furniture still has the value of entering the second-hand market for circulation, and then choose to continue listing the furniture or directly contact the platform for recycling at a lower price.

**Attach importance to the education of environmental protection concepts**

When consumers choose furniture products, “environmental performance” has replaced “price factor” as the primary factor of consumption in China, whether the recycling of used-furniture can be carried out effectively and lastingly depends on consumers’ cognition and understanding of the environmental protection. Until the concept reaches a certain level, measures related to waste furniture recycling can be normally implemented. Therefore, it is obligatory to strengthen consumers’ awareness of environmental protection and take effective measures to improve that of different ages, education levels, and family environments through short videos, news, advertisements, etc. (Guinee et al. 2011) Meanwhile, in the process of publicity, related organizations should pay attention to the producing process of furniture from design, material selection, production, use to recycling, and guide consumers to quickly and accurately classify used-furniture in usage.

**Conclusion**

Low-carbon economy is the inevitable course for China to transform economic mode and adjust economic structure. As an important part of China’s economy, the industry of furniture actively develops low-carbon economy, which is conducive to the furniture industry to undertake the responsibilities of environmental protection, improve the utilization efficiency of wood resources, and develop a new type of furniture manufacturing process. Improving national used-furniture recycling system is the core of the furniture industry’s realization of a low-carbon economic model. It effectively solves the problem of wood resource shortage and waste, and achieves eco-environmental protection and economic development. In view of the large output of used-furniture, the shortage of furniture manufacturers to undertake the social responsibility of used-furniture recycling, and the weak awareness of consumers, this paper proposes several development strategies for the recycling of used-furniture in China. The government needs to establish a used-furniture recycling network to supervise and support furniture manufacturers to take responsibility for recycling, formulate recycling standards, and improve the system. For furniture manufacturers, they need to improve the durability of furniture, postpone the speed of furniture replacement, design furniture for easy recycling, improve the recyclability, and develop new models and technologies for furniture recycling, so that the overall benefits of furniture manufacturing companies are to be improved. At last, for consumers, they need to improve the consumption concept, care about the education of environmental protection, reduce the social pressure on dealing with used-furniture, and improve its recycling efficiency. Construction of used-furniture system in the future is of positive significance to solve the shortage of resource supply and reduce waste of resources. It aims to accelerate towards a circular economy society and realize the sustainable development of society.

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**Declarations**

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