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Modular System of Cabinets for Mass-Customized Furniture

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Abstract
To support the establishment of modular systems for Mass Customization furniture enterprises, cabinet products are used as research objects to establish a modular system for cabinet products suitable for medium-sized enterprises. It is proposed to classify cabinet products according to structural characteristics and divide cabinet products into cabinets, tables, and special function categories based on the principles of standard structure, replicability, and reusability. A Mass Customization furniture production method is established in which a combination of unit modules is composed of a combination of furniture. Then, panels and accessories are selected to form the final furniture combination model.

Keywords: Mass Customization; Cabinet; Modular

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1.0 Introduction

In China, the personalized needs of consumers are growing day by day. The customized furniture industry needs to face the increasing competition and consumer demand. The traditional large-scale production method can no longer meet the diversified needs of the market. Although customized furniture for the whole house provides personalized choices to a certain extent, its high cost and long cycle still need to be addressed. Therefore, the modular design of mass-customized furniture has become an important research direction. This paper aims to explore the modular system of cabinet products in large-scale customized furniture to provide a theoretical basis and practical guidance for transforming and upgrading the furniture industry.

1.1Research background

With the rapid development of computers and manufacturing technology and the transformation of the world market from a relatively closed to an increasingly open, the competitive environment of panel-type custom furniture manufacturers has undergone tremendous changes. This is reflected in the shortening of product life cycles, the diversification and personalization of customer needs, and delivery time becoming the main competitive factor (Xu, 2020). Custom furniture manufacturers must constantly adapt to market changes, adopt advanced business production processes, and reform modularly to stay invincible. However, traditional custom furniture has problems such as high cost, long cycles, and difficulty in standardized production. In order to meet the demand for large-scale production, various enterprises have adopted a similar modular system of unit cabinets, which are then combined with each other to become customers'

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furniture design solutions (Xie, 2021)。 Modular design, as a practical solution, achieves a balance between flexibility and economies of scale by breaking down products into several modules that can be independently designed, produced, and combined(Wu, 2024).

1.2 Problem statement

In China, with the development of industrialization, the variety of mass-produced customized furniture products is becoming increasingly diverse, and the processes are becoming more and more complex, which requires higher management systems for the production process. Establishing a suitable modular system for cabinet types can help enterprises simplify the variety of products and carry out classified production, simplifying the production process. There are the following problems in the production process of large-scale customized furniture: (1) There are many varieties of cabinet furniture on the current market, and customers have personalized needs. There is an urgent need for a modular system to classify products (Fang, 2022). (2) Unified classification standards are needed. Modular design often lacks a unified standard, making it difficult to interchange or combine modules between different brands or series of the same brand, limiting the flexibility and efficiency of mass customization(X. Liu, 2021).

1.3 Research questions

We know that establishing a modular system for custom furniture cabinets can make it easier to classify cabinets with complex varieties so that different custom furniture can be classified and produced, reducing the difficulty of production. Therefore, there are two research questions:

(1) What can the establishment of a modular system for custom furniture cabinets bring?

(2) How can classification make modularization easier?

1.4 Aim& objective

The results of this study will provide a modular system for cabinets of Mass Customization furniture and provide customized furniture companies with another feasible modular system solution. The research objectives of this paper are

(1) to discuss the feasibility of establishing a modular system for cabinets of Mass Customization furniture;

(2) Discuss the classification method of the modular system for cabinets of mass customization furniture.

2.0 Literature Review

2.1 Current status of mass-customized furniture production

Mass customization was first proposed by Stan Davis in his 1987 book "The Perfect Future". He claimed that this production method can meet the personalized needs of customers without sacrificing the interests of mass customization enterprises(Davis, 1989). Mizael S. Falheiro believes that there are three ways to mass customize products: modular, adjustable, and size customization. He proposed that modular design is a design technique, and modular products are attracting people's attention. Through modular production, people can customize products by assembling several modules. Combined with the theory of mass customization, modular production of large-scale customized furniture can be achieved (Falheiro et al., 2022).

In China, some scholars have studied the production mode of large-scale customized furniture. Xiong Xianqing believes that large-scale personalized customization has provided new ideas and methods for the transformation and upgrading of traditional manufacturing. The curtain of intelligent manufacturing has been lifted, and traditional manufacturing is transforming towards personalized customization and digital production(Xiong, 2020). Xiong Xianqing systematically proposed that the core of large-scale customized furniture mainly includes digital design, integrated production, information agile supply chain management, and other technologies in the furniture production process. Through mass customization, the manufacturing technology of furniture has been improved, the pace of informatization has been accelerated, and the goal of controlling the design, production, sales, logistics, and capital flow of enterprises, as well as coordinating the operation of customers and suppliers, has been achieved. This has formed positive feedback within the enterprise, between enterprises and customers, and between enterprises and suppliers, enabling mass customized furniture to gain competitive advantages in terms of cost, speed, and differentiation. Based on the research objectives and the current situation of personalized large-scale customization, Zuo Yi proposed that in the design and research of furniture customization services, it is necessary to reasonably plan and provide the content and methods of customization modules, realize the personalized needs of service users, construct a complete customization service model, and guide users to complete customization activities in an orderly manner (Zuo, 2020).

2.2 Modular production

Modular customized wardrobe is the design of customized wardrobes into different modules, and through the combination of modules, various styles and functions of wardrobes can be obtained, which is conducive to production and can improve the efficiency of designers(Wang, 2021). With the increasingly fierce market competition, enterprises need to gain competitiveness at lower costs and higher efficiency. Modular design and production of large-scale customized furniture can solve this problem. The modular concept can bring greater flexibility and market adaptability to large-scale customized furniture. The sensory characteristics of modular furniture are different from traditional furniture, presenting standardized, modular, and universal features (Z. Liu, 2024). Any production mode (including MC) requires product development and design methods that are adapted, matched, and compatible with it. The modular design method for furniture based on the concept of "modularity" (combining individuals with independent personalities according to

different needs) is a new design approach and a new way of thinking. This is a simple yet profound transformation in the field of design that helps solve complex problems (Ouyang, 2024).

3.0 Methodology

3.1 Literature Research

The literature Research will be conducted in this study as one of the research methodologies. To collect existing academic literature on the production process of mass-customized furniture and the modular production system of cabinet-customized furniture. A literature review is a systematic, explicit, and repeatable design for identifying, evaluating, and interpreting existing records. The analysis of documents aims to develop materials that do not have to be created based on the data collected by the researcher. Literature reviews usually have two purposes: to summarize existing research by identifying patterns, themes, and issues. Second, this helps to determine the conceptual content of the field and contributes to theoretical development. The data collected for the study is a comprehensive summary of the production process of mass-customized furniture and the modular production system of cabinet-customized furniture, as background information to understand the current status of mass-customized furniture before conducting more in-depth research. Then, we use the same method to gain an in-depth understanding of mass-customized furniture and modular thinking based on existing literature to determine the establishment of a modular system for mass-customized furniture. Data collection includes collecting journal articles published on the website. The literature search is guided by keywords such as Mass Customization, Cabinet, and Modular. Finally, the results of this study will provide insights into the modular design and production of mass-customized furniture to develop better upgraded industrial production in the future and be competitive in the industry competition. （Fig. 1）.

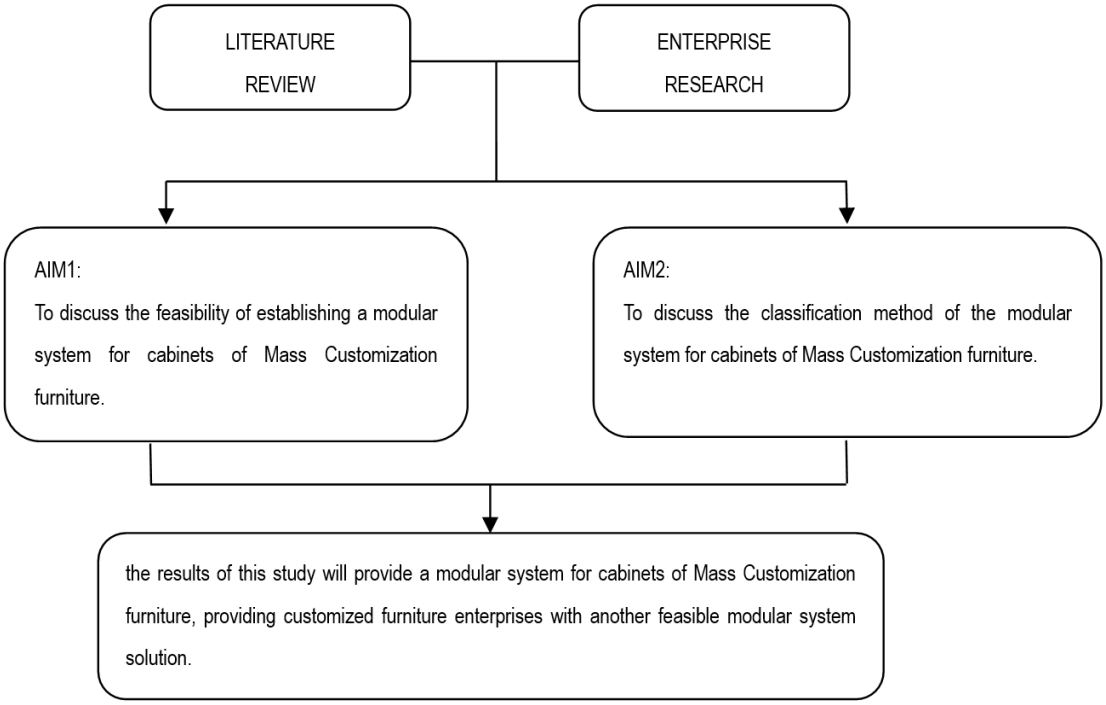


Fig. 1. Research Process.

3.2 Enterprise Research

As a direct, in-depth, and practice-oriented research method, enterprise research is significant for obtaining first-hand information, understanding industry status, discovering practical problems, and verifying theoretical hypotheses. The enterprise research aims to gain a deeper understanding of the modular system practice of mass-customized cabinet products in the furniture industry, including the specific application of modular design, optimization of production processes, collaboration in supply chain management, strategies for meeting customer needs, as well as cost control and product quality management. Through enterprise research, we will collect data, analyze cases, and summarize experiences to provide empirical support for building a scientific and reasonable modular design framework. This study selected Guangdong Saier Risheng Home Furnishing Technology Co., Ltd. as the research object. Mr. Zhou Wenming, the company's general manager, was interviewed. He pointed out that the custom furniture industry is highly competitive. After modular upgrades from furniture design to furniture production, business management and production cycles have simplified processes, improving competitiveness.

4.0 Findings

4.1 Classification of Mass Customization Furniture

There are many ways to classify mass-customized furniture, which can be divided into multiple dimensions such as function, material, design style, etc. In order to facilitate production, this study will use modular design to decompose the product into several standard structures, replicable and reusable units through the essential functions of cabinets, to achieve diversified product combinations and rapid production. This study decomposes cabinet furniture into modules such as three-dimensional cabinets, tables, and unique function cabinets. Each module has standardized interfaces and sizes to facilitate the combination and replacement of different modules. (Fig.2).

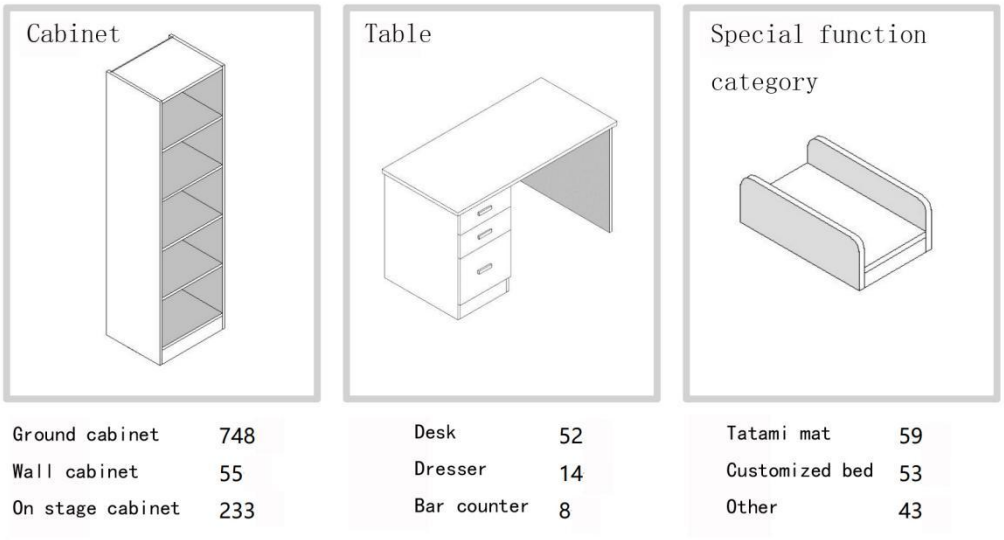
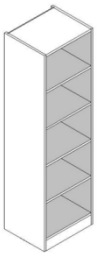
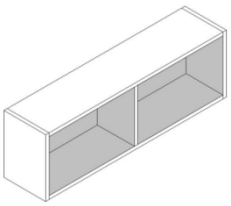
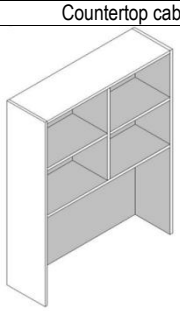


Fig.2. Basic modules of furniture

4.2 Modular cabinet system for mass-customization of furniture

The modular cabinet system for mass-customized furniture is an efficient and flexible production method that combines the personalized needs of customized furniture with the efficiency advantages of industrialized production. The furniture is divided into several independent modules with specific functions and standardized sizes. These modules can be combined in different ways to form a variety of furniture products. Cabinet modules can be divided into three modules based on their characteristics: floor cabinets, hanging cabinets, and countertop cabinets. The characteristics of a floor cabinet are that the side panels are floor-to-ceiling, have footlines, and use a 5 mm backboard. It is placed on the ground, such as wardrobes, bookshelves, entrance cabinets, display cabinets, wine cabinets, TV cabinets, shoe cabinets, curved cabinets, corner cabinets, and other cabinets. The characteristics of a countertop cabinet are that it has no footings and no tabletop, and it can be divided into two types: bottom and no bottom. It is generally placed on a desk, a tatami mat, or a cabinet.

Table 1. Structural Feature Classification - Cabinet Category

Cabinet	Floor cabinets	Hanging cabinets	Countertop cabinets
Picture			
Characteristic	Side panel landing, with foot lines, 5mm backboard, and a tabletop when the height is less than 1600mm	No foot line, no tabletop, 18mm backboard	No foot line, no countertop, available in two types: bottom plate and no bottom plate
Use to	Placed on the ground	Placed on the wall	Placed on desks, tatami mats, and cabinets
category	Wardrobes, bookcases, entrance cabinets, display cabinets, wine cabinets, TV cabinets, shoe cabinets, curved cabinets, corner cabinets	wall cupboard	On stage cabinet

According to the modular classification of cabinet types above, they can be further refined into the following categories: For example, floor cabinets can be further refined into single-sided cabinets, corner cabinets, and circular arc cabinets; hanging cabinets can also be refined into Single-sided cabinets, corner cabinets, and circular arc cabinets; and the cabinet on the stage can be refined into no baffle, with baffle, and no bottom plate(Fig.3).

This classification method summarizes all products that meet the personalized needs of customers in terms of product design. Designers can select various basic modules from the above modules when designing products and then combine them into combination furniture that meets the personalized needs of customers. In the production process of products, factories can arrange production lines according to modules and even simultaneously produce different modules, simplifying the production process.

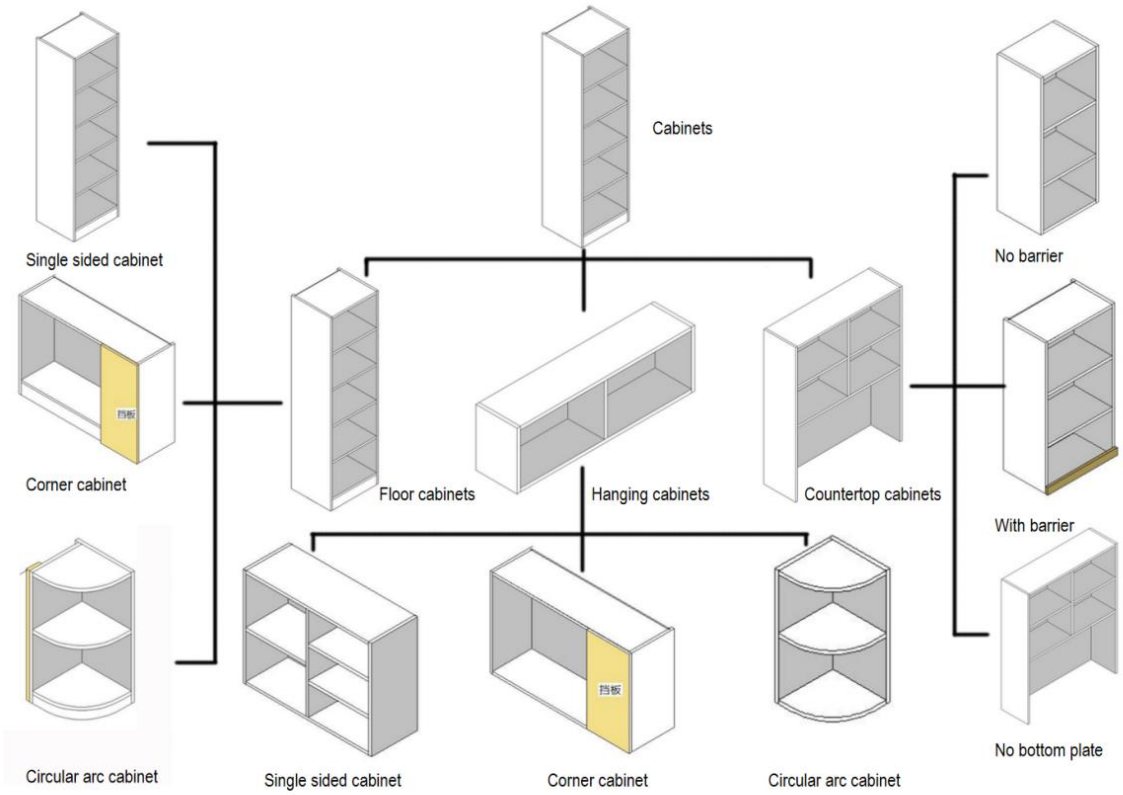


Fig.3.Collection of Cabinet Modules

In summary, modular design has essential application value in mass-customized furniture. By modularizing the design and production of cabinet features, not only can production efficiency be improved and production costs reduced, but the personalized needs of consumers can also be met.

5.0 Discussion

5.1 The impact of modularization on personalized customer satisfaction

Modular design provides customers with a wide range of personalized choices. When customers communicate with designers in the early stage, they can choose different customized furniture modules from the module library of customized furniture enterprises based on their preferences and needs, their family's design style, and the on-site situation. This combination not only meets customers' customization needs but also forms a unique customized furniture product. This flexible customization method not only meets the personalized needs of customers but also enhances the market competitiveness of customized furniture enterprise products.

5.2 The impact of modularization on production efficiency

In the research of large-scale customized furniture enterprises, we learned that the investment in modular design and modular production has significantly improved design and production efficiency. Due to the classification based on the characteristics of customized furniture products, while meeting the personalized needs of different families, the design reduces human errors and improves the efficiency of the communication process. In the production process, different modules can be produced independently and quantitatively, reducing the dependence and waiting time between production links. They can be assembled through standardized interfaces, significantly shortening the production cycle. Modular production, through standardized and modular design, enables materials and equipment in the

production process to be more fully utilized. Enterprises can flexibly adjust the quantity and combination of modules according to market demand and order situation, avoiding resource waste. In addition, modular production also promotes the sharing and reuse of production equipment, reducing production costs. Meanwhile, modular design makes the production line more flexible, quickly responding to market changes and achieving on-demand production.

5.3 The impact of modularization on cost control

The impact of modularization on cost control is multifaceted, including reducing design costs, optimizing procurement costs, reducing manufacturing costs, lowering after-sales service costs, and enhancing cost control capabilities. These impacts make modularization necessary for enterprises to improve production efficiency, reduce costs, and enhance market competitiveness.

Firstly, modular design divides the product into multiple independent modules, each with specific functions that can be independently designed, produced, and used. This design approach allows the design team to reuse existing validated modules, significantly reducing design risks and minimizing the need for new designs. At the same time, modular design standardization and normalization also reduce the possibility of design changes and rework, further reducing design costs. Second, modular production enables enterprises to organize production activities more efficiently. Due to the independent production of each module, enterprises can produce multiple modules in parallel, thereby shortening the production cycle.

Meanwhile, modular production also promotes sharing and reusing production equipment, reducing equipment investment and maintenance costs during production. Finally, modular design enables enterprises to respond more flexibly to changes in customer needs. Customized furniture enterprises face ever-changing customer demands, and different customers have different designs, structures, sizes, and material requirements for customized furniture. Enterprises can quickly combine products that meet customer needs by adjusting the combination and quantity of modules. This flexible production method helps enterprises maintain their competitive advantage and enhance their cost control capabilities.

6.0 Conclusion& Recommendations

6.1 Limitations of this study

The research on the modularization of mass-customized furniture cabinets is of great significance in promoting innovation and development of the furniture industry, but it also faces limitations in technology, market, and production. In order to overcome these limitations, enterprises need to strengthen technology research and development, optimize production processes, strengthen supply chain management and coordination, and continuously explore the possibility of personalized customization.

6.2 Conclusion

The research on the modularization of mass-customized furniture cabinets is of great significance in promoting innovation and development of the furniture industry, but it also faces limitations in technology, market, and production. In order to overcome these limitations, enterprises need to strengthen technology research and development, optimize production processes, strengthen supply chain management and coordination, and continuously explore the possibility of personalized customization.

6.3 Recommendations

The study of modular cabinet systems for mass-customized furniture is one of the essential directions for transforming and upgrading the furniture industry. The modular furniture customization model can inject new vitality into furniture design and production, improve design mode and design efficiency, simplify the production process, and improve production efficiency. Through modular design, we can balance flexibility and scale benefits, meet the personalized needs of consumers, reduce production costs, improve product quality, and improve production efficiency and market competitiveness. Based on the summary of previous research results, this paper proposes a modular cabinet design system suitable for mass-customized furniture and verifies its feasibility and effectiveness through field visits to furniture manufacturers and markets.

In the future, with the continuous advancement of technology and the continuous changes in the market, modular design will play a more critical role in the furniture industry. The modular cabinet system should also strengthen the research on the modular design on the existing basis, explore more innovative design methods and connection methods to improve the flexibility and applicability of modular design, improve the modular system to ensure the compatibility and interchangeability between different modules to meet the changing needs of the market; improve the level of production automation, introduce advanced robots, CNC machine tools, and other equipment to achieve more efficient and accurate processing and assembly processes; strengthen market research and customer demand analysis to meet more personalized customization; Increase investment in technological research and development, promote the application of new technologies, new processes, and new materials, and promote technological innovation and industrial upgrading.

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Contribution to Related Field of Study

The contribution of this paper to the field of modular customized furniture is mainly reflected in the following aspects:-

Modular design provides customers with a wide range of personalized choices. Customers can choose different modules from the module library of customized furniture enterprises based on their preferences, needs, home design styles, and on-site conditions, forming unique customized furniture products that not only meet customers' customization needs but also enhance the market competitiveness of customized furniture enterprise products.

The modular design and production of large-scale customized furniture enterprises have significantly improved design and production efficiency. Modularization has multiple impacts on cost control, including reducing design costs, optimizing procurement costs, lowering manufacturing costs, reducing after-sales service costs, and enhancing cost control capabilities. Modular design enables enterprises to respond more flexibly to changes in customer needs and maintain a competitive advantage.

References

Davis, S. M. (1989). From “future perfect”: Mass customizing. *Planning Review*, *17*(2), 16–21. https://doi.org/10.1108/eb054249

Falheiro, M. S., Sato, A. K., Bigon, C. B., Souen, J. H., Nascimento, J. B. P., Martins, E., & Tsuzuki, M. S. G. (2022). Smart Configurator to Integrate Customized Furniture Design and Fabrication. *IFAC-PapersOnLine*, *55*(2), 205–210. https://doi.org/10.1016/j.ifacol.2022.04.194

Fang, T. (2022). *Research on Digital Operation Management of ACustomized Furniture Enterprise* [Master Thesis]. UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA.

Liu, X. (2021). Similarities and Diferences Between Modular Furniture and Traditional Furniture in the Production Process. *China Forest Products Industry*, *58*(12), p.125-127. https://doi.org/10.19531/j.issn1001-5299.202112030

Liu, Z. (2024). Modular Furniture Design Based on Kansei Engineering and Analytic Hierarchy Process LIU. *PACKAGING ENGINEERING*, *45*(8), 141-149,158.

Ouyang, Z. (2024). *Research on Building a Digital Twin Line for Intelligent Manufacturing Oriented Mass Customization Wardrobe* [Doctor Thesis]. Central South University of Forestry & Technology.

Wang, S. (2021). *The Method and Application of Modular Customized Wardrobe Based on Similarity Smart Design*. Central South University of Forestry & Technology.

Wu, B. (2024). Research on Modular Design of Furniture based on Modern Lifestyle. *SHOES TECHNOLOGY AND DESIGN*, *4*(11), 162–164.

Xie, S. (2021). *Research and application of large-scale custom furniture product development process* [Master Thesis]. South China Agricultural University.

Xiong, X. (2020). Digital design and manufacturing of furniture enterprises oriented to intelligent manufacturing. *Journal of Forestry Engineering*, *5*(4), p.174-180. https://doi.org/10.13360/j.issn.2096-1359.201908017

Xu, B. (2020). New Pattern of Customized Furniture Market after the Opportunity Dividends’ disappearance. *Furniture and Interior Decoration*, *009*(04), 9–10. https://doi.org/10.16771/j.cn43-1247/ts.2020.04.001

Zuo, Y. (2020). *RESEARCH ON THE DESIGN OF CUSTOMIZED SERVICE PROCESS FOR LARGE-SCALE PERSONALIZED FURNITURE* [Master Thesis]. Hebei University ofTechnology.