The Impact of Virtual Reality (VR) Applications in Ming-style Furniture Designs

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Abstract. The research investigates how VR applications can radically change Ming-style furniture design. It explores the complex factors that control how satisfied a person is with furniture designed through VR. The purpose of this study is to understand the complex effects of VR technologies on the creative process and consumer instincts through the DoE research methodology, as well as the experience level. Utilizing VR applications in the design of Ming-style furniture sparks important inquiries concerning the effectiveness, practicality, and attraction of virtual design surroundings. To enhancing the processes and effects of designing, it is essential to appreciate how design method, acquaintance level, furniture captiousness, and the mechanism of additional viewpoint that influences the satisfaction of designers, so as to fully utilize the VR technology. 385 individuals who used Ming-style furniture in Suzhou completed a survey over the Internet, which contributed significant insights into VR-mediated design experiences. By determining satisfaction perception, collecting data via Likert scales, and then using SPSS, core-region data is processed, which resulted in examining the correlation of multi-regression among the variables. The results show that there is a strong connection between Virtual Reality Implementation and User satisfaction of Ming style. This investigation emphasizes the great importance of high-quality ways to receive feedback and users who are experienced in how they make users happy while using virtual and real-world ways to communicate means of doing or reaching something and how skillful they are at creating visual images in the mind of Ming-style furniture design. By clarifying the numerous forces that underline what users see, feel, and learn from a product line, this work makes more likely the discovery and spread of counter-intuitive products for everyone.

Keywords: Virtual Reality; Ming-style furniture; User satisfaction; Design method; Feedback mechanism; Experience level.

1. Introduction

The union of technology and creativity has long provided the impetus for innovation in myriad fields, and Virtual Reality (VR) is currently reimagining design-driven industries [1-3]. In the intricate world of furniture design, with its rich cultural heritage and dexterous craftsmanship, the integration of VR applications profoundly impacts both the creative process and the user experience.

The Ming dynasty was a cultural renaissance, art refinement of the era, Ming style of furniture, smooth and simple lines, with exquisite craftsmanship, elegance has been hailed as an immortal legend works. The Ming-style furniture, the form of integration, function, reflected a thought culture completely and the beauty of a traditional beauty of life, with the characteristics follows the Ming Dynasty furniture culture and aesthetic pursuit [4]. Today, the revival of Ming-style furniture in the contemporary design scene brings us not only a glimpse of the past, but also a new way of integrating the design concept based on history into the present era, forming a new multidimensional culture that rolls history forward.

By mastering the innovations of the virtual reality, exploring the Ming Dynasty furniture of forecasting design, to carry out all aspects of the multisubject angle, the virtual environment of the future. When we put the virtual reality in the scenario, the modern people have a profound Ming Dynasty furniture the extended performance of the scenario, whether from the process of production and sales interaction, or from the user limit function mode, are showing unprecedented charm [5].

Design Method discusses the basic way of creating a Ming-style furniture design. The design of traditional methodology is basic which is drawing by hand and building physical model [6]. This methodology has been considered to the origin methodology for designing. With natural and man-made features, trial-and-error this process has been doing all the time. It is same as VR simulation, it is provided the new way of drawing by computer, and the pilot of VR feels they are in the furniture virtual world, to operate the virtual furniture, and to see the furniture in 360 viewing angle.

Experience Level is measured to evaluate proficiency in manipulating VR interfaces and applications for digital design [7]. Fresh users, who have considerably less chances to be exposed to VR and less experienced, are considered unfamiliar with the virtual environment. On the contrary, professional users are familiar with VR technically and practically. Doing this can differentiate the distinctive experience and problems among different users to the expertize effect on the effectiveness of VR applications. It can also find the obstructions or incentives that can affect user-satisfied in Ming-style furniture design too.

Furniture complexity is a concept that captures the subtle details embedded in Ming-style furniture design. Besides its diverse visual content ranging from simple to complex directions, furniture complexity exerts critical influence on the design strategy and user perception of each furniture work. With ease of comprehension and manipulation in virtual environments offered by simple design, the increasing cognitive challenges as well as sophisticated digital modeling techniques are required for complex composition. By examining furniture complexity's correlative relationship with user satisfaction, it aims to unfold the interaction between design complexity and technology affordance, providing further suggestion for VR integration in Ming-style furniture design under different context [8].

The Feedback Mechanism is used to provide a structure for examining the way that VR-mediated environments might provide feedback about designs over time [9]. Real-time feedback mechanisms give insight and make adjustments while design is happening, supporting iterative exploration and increasing user engagement. Conversely, delayed feedback mechanisms insert a time delay between design iterations and evaluations, which makes it harder to be creative and more frustrating. This research examines these two feedback mechanisms and attempts to understand the effect of different types on user perceptions/satisfaction in the context of Ming-style furniture design.

The User Satisfaction Score is the critical measure for evaluating the effectiveness and attractiveness of VR applications in Ming-style furniture design [10]. The user satisfaction score is largely determined by the real experience brought by the application, in addition to this, the comfort and aesthetic brought by using the application, which shows the design style of VR technology and the user's real feelings.

By gaining the user's feedback and perception from the perspective of evaluation the quality of the performance of the VR application, the paper accumulates an all-round history of these performances and determines the user's satisfaction of the performance of the VR application, which was analyzed through neural network of VR technology and proposition of user's perception [11, 12]. The result of the analysis confirms the reason behind the user's satisfaction of the VR application used in Ming-style furniture design.

1.1. Problem Statement

Introducing VR technology into the design of Ming-style furniture, a field that heavily relies on VR technology, can radically transform its design procedure. The Design Method is what this study revolves around. In comparison, the traditional mode uses hand-drawn diagrams and physical models, which are to be completely replaced by VR simulations in the future. In fact, "seeing theories" of furniture design and their physical models represent in popular decades, while VR technology has revamp completely the design procedure or imagination of the Chinese Ming-style furniture [13]. How different by the different input methods and design visualization models, are these two design methods? Through the research how the user satisfaction of VR technology can affect the Chinese Ming-style furniture design models and design concepts.

Experience Level is a status division for users who interact with the interfaces of Virtual Reality. In contrast to the experienced users, novices have limited knowledge and skills in operating VR applications.

An investigation on this dimension leads to the realization of unevenness in experiencing and encountering challenges when users of different levels, especially for some applications of virtual reality. It also unveils the effectiveness of the functions of virtual reality is conditional and dependent on user expertise. Which exhibits the obstacles or facilitators of user pleasant using regarding Ming Style furniture design especially [14, 15].

The Complexity of Furniture Design encompasses the complex elements in Ming-style furniture designs, ranging from simple composition to intricate designs [16]. The complexity of furniture designs profoundly influences the design and also affects the users' perception, which not only reveals the cognitive burden on users, but also investigates the compatibility of VR applications among varied design complexities. By disentangling the consequences of these phenomena on user satisfaction, this study aims to reveal the interplay between design complexities and technological affordances, thereby identifying the optimal contexts to integrate VR into Ming-style furniture design.

The Feedback Mechanism is an exploration of the temporal sophistication in how design feedback is delivered. Immediate feedback mechanisms allow the designer to gain immediate insight and make adjustments during the design process. Delayed feedback mechanisms will result in a temporal lag between design iterations and evaluations. Ensuring timely and contextualised feedback is an important factor to iterative design, and improving the user satisfaction. This research aims to identify the differential impacts on user perceptions and satisfaction of immediate and delayed feedback through comparative analysis in the realm of Ming-style furniture design.

At the heart of this study is the User Satisfaction Score (USS) that stands as a key metric to assess the efficacy and desirability of VR application in Ming-style furniture design. User satisfaction, in its broadest definition, involves realism, comfort, and aesthetic satisfaction, which could provide a holistic user experience incorporating throughout the design process [17]. By gathering user comments and perceptions, that provides a comprehensive perspective to the effectiveness of VR application and also uncovers the hidden reasons underlying user satisfaction in the context of Ming-style furniture design. This study attempts to delve into the complex effects of VR application to Ming-style furniture design, and disassemble various components that define the substantial role user satisfaction plays. The framework for study is given below:
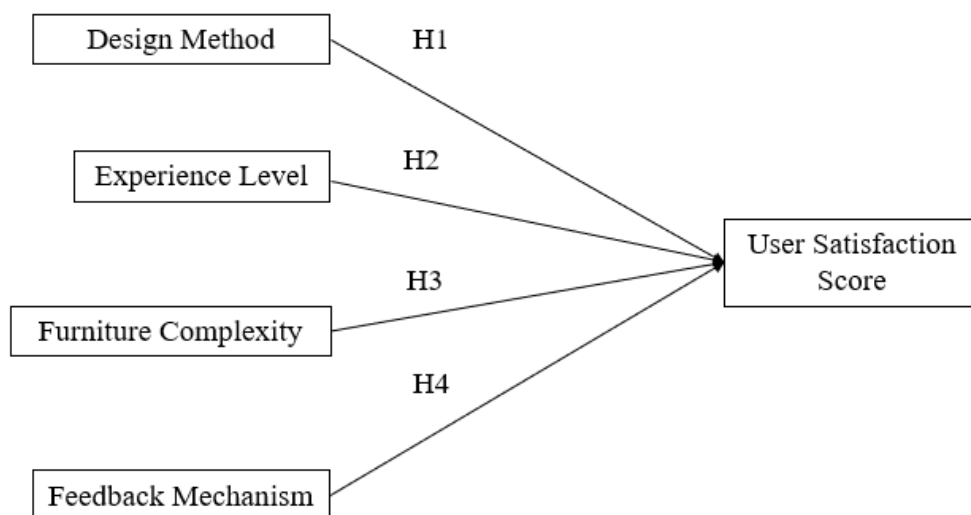

Figure 1. Research Framework

2. Literature Review

The term "virtual reality technology" can describe a wide range of applications that use computer, 3D modeling, physical engine, and sensor technologies to simulate a three-dimensional environment, giving users the impression that they are actually present in that setting [18, 19]. To create and immerse oneself in a real-world setting in a 3D virtual environment, it is essential to provide the senses of sight, sound, smell, and taste.

The human senses see virtual reality as genuine, although it is actually a work of fiction [20]. On the other hand, you usually get the right answers when you act on the fiction. There are a lot of people doing research on VR technology for a variety of purposes, and the algorithms used in this research are rather advanced, especially when it comes to the first three points. The five main properties of virtual reality technology are as follows: the ability to perceive virtual objects in three dimensions, the presence of virtual objects, emotional sensitivity, closed-loop interaction with the virtual environment, and dynamic presentation of virtual things. Among the most fundamental features of VR technology are the ability to see virtual objects in three dimensions, to feel as though virtual items actually exist, and to interact with virtual environments in real-time [21].

By utilizing virtual reality technology, one can converse with a computer in a way that is completely natural, as if they were interacting with objects in their regular surroundings. Releases the individual from the burden of managing a computer. Various fields of study are necessary for virtual reality technology. These include technologies for three-dimensional terrain modeling, multi-dimensional information representation, real-time processing, fusion of participants and scenes, concurrent processing, object simulation, computer graphics processing, technology for applying virtual reality interfaces to intelligent computer systems, and research based on network environments. Many different sectors, including the arts, education, entertainment, healthcare, and others, have made extensive use of virtual reality technology, which is a significant high-tech in the IT industry [22]. For instance, in order to help students understand the fundamentals of surgery more rapidly, medical professionals utilize computers to create virtual versions of human organs and tissues. Students can then practice surgical procedures in this environment, complete with the realistic feel of a scalpel slicing through human muscle tissue and bones. Virtual reality technology has several commercial applications in other nations.

In reality, the construction of the VR system will be based on the variations in certain applications and jobs. Consequently, there is a difference in the software and hardware that is actually used. Virtual environments, software, computers, and ancillary input/output devices are the five main components necessary for a virtual reality system to function formally [23]. In it, "virtual world" means an interactive virtual environment that includes databases and models to back up scene models, dynamics, and related physical properties, among other things. Computers offer supplementary computational capabilities to accomplish picture transmission and processing, and designers, in this setting, are able to engage in continuous observational activities from a variety of perspectives.

They are high-end graphics processors or specialized personnel that can efficiently process data and display images; the software is part of the virtual reality software platform that is made available for real-world application objects. Vega and Virtools are two of the most popular external devices used in the development process [24]. Input devices are used to recognize control data from the user. Common examples include 3D position trackers, data equipment, sound input, and three-dimensional probe. Output devices are responsible for sound output, force feedback, and three-dimensional graphics, creating an immersive experience for the operator. Data capturing devices, binocular omnidirectional displays, and part models are all examples of hardware facilities that can be found in both the software and hardware systems of actual equipment [24, 25].

Handcrafted furniture makes up the majority of traditional furniture. Some easy activities in furniture manufacture can now be undertaken by machines, thanks to technological advancements and the introduction of electric tools. The machine creates neat shapes, but the lines are rigid and lack vitality. The only carvings that are more refined, imaginative, energetic, and full of life are those done by hand. The literature review will go on describing about various symbols, dynasties and era that has highlighted and made use of some amazing art forms which became so popular that it turned out to be accepted, used and loved by many over centuries and still can be seen in modern day furniture designs in China as well as across the Western World. Traditional cultural emblems, on the other hand, have a consistent ornamental strategy throughout the creation process [26]. The Phoenix and the Dragon are considered to be classic good luck emblems. With that, the aesthetic concept of contemporary Chinese culture into modern furniture design will also be discussed in the literature review.

There are six contemporary Chinese furniture designs that are leading the industry at present. Chinese furniture design has been observed to look back to its cultural rules and thereby reinvigorating past techniques forms as well as materials. The majority of furniture even during Ming and Qing dynasties was

handcrafted from padauk, rosewood, as well as other high-quality hardwoods. Its creative attractiveness is lasting and is still liked by people today, thanks to its complex production method, elegantly simple style, elegant sculpting, accurate and elegant mortise-and-tenon construction, and silky lines. Hardwoods including rosewood and padauk were utiliszd in Chinese classical furniture from the Ming and Qing periods. Hardness, corrosion resistance, and different textures are all common properties of these woods, and furniture manufacturing of them is both beautiful and lasting. The majority of traditional furniture is produced by hand. Although, because of the advancement of technology and the introduction of electric tools, some simple tasks in furniture manufacturing can now be handled by machines. However, it cannot totally replace manual labour. The structural portion of Chinese traditional furniture, mortise-and-tenon craftsmanship, is the most elegant aspect of the furniture [27]. In ancient China, connecting bits of wood with nothing more than wood itself was a typical carpenter's art. It refers to the splicing of two components via concave-convex splicing. The "tenon" is the protruding element, whereas the "mortise" is the sunken part. Fit them together neatly when coupled. This approach relies entirely on the mortise link and does not use nails or glue. Spring and Autumn (770-476 BC) as well as Warring States (475-221 BC) dynasties, which gained maturity during the Song Dynasty (960-1279) and peaked during the Ming and Qing dynasties. Its major benefit is that it protects the wood from being damaged by nails, and it is extremely stable and hard. All carpenters must know how to use the tenon-and-mortise system. During the Ming and Qing eras, Chinese furnishings reached their pinnacle. As a result, Chinese Traditional furniture is separated into two types: Ming-style and Qing-style.

The difference between the two is mostly determined by the work's style, form, and craftsmanship. The production skills of Ming-style furniture are well-known in Jiangsu Province, particularly in the area next to Suzhou. The construction emphasises function and aesthetic coherence, which is in line with the development of Chinese culture. It appears tiny at first view, but upon closer investigation, it reveals a certain appeal, and every feature is worth noting. The usage of lines is expressed in the linear variation of the shape of various portions, and the style fully embraces the allure of line art [28]. For illustration, the headrest board of most chairs has an S-shaped curve that complies with ergonomics while also fitting the natural shape of the human body. This is a really scientific curve. The bones of Ming-style furniture are, in general, the lines. Consecutive talented generations of Chinese designers led the new design movement through the cultural roots of ancient forebears' legacy of remarkable design. China's ancient culture in a design influenced the New Design movement in a significant way. Wen Hao founded the 'Hao style' brand in 2011, devoted to creating timeless furniture, a derivative of copper culture. Advanced technology is combined with traditional craftsmanship and redefined the Chinese boundaries in contemporary design and a Modern Chinese Lifestyle.

'Maxmarko', founded by Derek Chen in 2010, was inspired by Taoism philosophy which called as 'Harmony In Diversity'. Originally, it was founded as a design and research center, for the designers to create and explore truly inspired and unique products that showcase the new exciting voice of Chinese Contemporary Design. Doors in Chinese homes of today have an incredibly modern look. Being simple, sleek, lighter, muted tones, straight lines, they became lucrative, attractive, and demanding in China as well as in Western Countries. Bentu's Design, another Chinese studio where trash is turned into treasure, revealed the Terrazzo collection in 2017, made from specks of marble, granite, glass, shell chips mixed with a cement or epoxy binder. The result is a sleek surface with glittering chips that can be interchanged to match the surrounding aesthetic [29]. With globalization, Chinese design became influenced by Western-style including design theory, design practice, and education. But today's China has been improved and they are innovating and creating their own brands independently. Original designs with cultural values that were promoted in the last decades have become prominent through various designing fields as growing need for support the development economically.

The manufacturing of furniture during the Ming Dynasty is credited with a number of important firsts in the industry [30]. In the annals of the history of furniture manufacture all over the world, that particular era marks the high point of both the manufacturing technology and the quality of the craftsmen. The design and manufacturing processes that it pioneered are still in use today. Ming-style furniture from Suzhou is distinguished from other furniture manufactured during the Ming Dynasty because it has forms that are simple and graceful, materials that are valuable and of high quality, and a size and structure that are appropriate for the piece. In 2006, furniture designed in the Ming era was designated as the first intangible

cultural item in China [31]. The Lu Ban Jing Jiang Jia Jing is the earliest book that has drawings and prose about Ming-style furniture [32]. It consists of three volumes and was produced during the Wanli Period of the Ming Dynasty (1572-1620). An addendum to the book was written by Wu Rong. The book provides detailed illustrations of the shapes of a wide variety of furniture kinds, in addition to providing an overview of the building process and living furniture. This book features images of furniture from the Ming Dynasty, together with descriptions of its name, usual usages, measurements, and craft materials used during that time period.

The term "Ming-style furniture" can apply to a broad variety of different pieces of furniture. It does not just refer to pieces of furniture that were manufactured during the Ming Dynasty; it can also refer to pieces of furniture that were made of inexpensive wood and included intricate carvings [33]. People are currently talking a lot about "China style," with various eras of Chinese style having varying meanings. The emergence of Chinese style has given design from all spheres of life a fresh appearance [34]. Ming period furniture in terms of how Chinese style is used in interior design. In the history of ancient Chinese furniture, Ming furniture is unquestionably a classic. It is also exceptional in the history of furniture. Nationality is essentially the key to cultural legacy in the process of globalization. We refocus our attention away from internationalization and toward traditional culture. Following, I believe there are two factors that have so far influenced Ming furniture. The first point is the Ming Dynasty furniture's artistic emblem. Simple second [35]. Visual viewpoint and modern home design are both perfectly displayed. People's conceptions of life are gradually altering as a result of social growth and a rise in living standards. Thought and desire were developing, yet food and clothing standards were far from satisfying modern people's needs. The evolution of the times and the perceptual prominence of people's views produce beauty. In conclusion, there are artistic references around the house. The Chinese design philosophy's supremacy is still at the core of the traditional design symbol, which takes on a slightly different expression at each step [35]. Modern designers point out that the design profession should have a heritage mission and a sense of design responsibility. International recognition will be higher when nationalism is inherited and enhanced. The so-called design exam China is not an assessment of our creative prowess, but more of our ability to maintain inner peace while contemplating the best of the past.

The best design concepts must be passed down through tradition. We should consider the cultural heritage when designing in the future. It serves to preserve the very core of human culture in addition to highlighting the fashion sense of contemporary furniture design. The structural characteristics of the piece of furniture offer support for this point of view. For instance, the back rests of the armrest chairs appear to be fashioned in the shape of S so that they can accommodate a person's back while also providing enough support. In addition, armchairs with a round back are created with the height and shape of their occupants in mind so that they can provide support in the armpit as well as the elbow region. Even if both traditional Chinese design and contemporary design are supportive of human values, the design effort is based on humanity and ritual [36]. This is due to the fact that the ancient Chinese design philosophy, like Western design philosophy, concentrated on the spirit of mankind. The limitations that were imposed on it by traditional culture were another factor that contributed to its development. In order to form the three-dimensional coordinates of vertical time and horizontal culture, the sustainable development of the modern traditional handicraft industry requires, on the one hand, a systematic organization of experience gained during the development process in the context of its historical context, and, on the other hand, a strategic drawing on the research of various contemporary disciplines. As a significant cultural asset, past experience is one of the main driving forces behind the ever-evolving nature of traditional handicrafts.

As a result, traditional handicrafts are contextualized here within the larger framework of human history and culture. Analyzing the Su-style furniture industry in the Ming Dynasty and its competitive advantages from a historical perspective. The Chinese place a high priority on the harmonious and integrated relationship between man and nature, which is a form of deep emotional communication. The usage of Chinese furniture materials exemplifies this principle perfectly. The grain and natural color of the original materials, as well as their natural features, are preserved in Ming-style furniture. This displays the ancient people's respect for the natural world and their capacity to think imaginatively. As has been aforementioned, the furniture of the golden period is considered to be mostly used as the designs are still preferred and liked by not only the Chinese people but also the people from the Western World. It has been discovered that China's progress is primarily reliant on its traditional culture [37]. China's national culture

is regarded as the cornerstone of the country's decades-long progress. Similarly, current society's industrial design is more than just an artistic creation activity; it also incorporates single technological and scientific tasks. It is also seen as a cultural reproduction of all of this industry's products. Chinese furniture reached its apex during the Ming and Qing dynasties. As a result, there are two forms of Chinese traditional furniture: Ming-style and Qing-style. The style, form, and quality of the piece indicate the distinction between the two. Ming-style furniture production skills are well-known in Jiangsu Province, notably in the Suzhou area. As a result, Suzhou-made furniture is recognized as a symbol of Ming-style furniture, often known as Suzhou-style decor. The following table showing comparison of existing studies.

Table 1. Existing Studies

Author (Year)	Objective	Pros	Cons
Radiawan et al. (2022)	Discuss various symbols, dynasties, and eras influencing Ming-style furniture and its incorporation into modern designs	Provides historical context and cultural significance of Ming-style furniture.	May lack specific analysis on contemporary applications and sustainability aspects of Ming-style design.
Wu et al. (2021)	Explore the traditional craftsmanship of mortise-and-tenon construction in Chinese furniture.	Highlights the elegance and stability of traditional woodworking techniques.	May not fully address the sustainability implications or modern adaptations of mortise-and-tenon methods.
Savage (2021)	Examine the construction and design principles of Ming-style furniture, particularly from Suzhou.	Offers insights into the aesthetic and functional aspects of Ming-style furniture construction.	Focuses primarily on historical and stylistic aspects, may not delve deeply into contemporary relevance.
Fan & Feng (2019)	Investigate the historical significance and craftsmanship of furniture manufacturing during the Ming Dynasty.	Provides valuable historical context and technological advancements of Ming-era furniture.	Might lack in-depth analysis on the contemporary relevance or sustainability aspects of Ming-style design.
Xu et al. (2021)	Analyze the Lu Ban Jing Jiang Jia Jing and its role in documenting Ming-style furniture construction.	Offers detailed information on Ming-era furniture documentation and craftsmanship techniques.	May not directly address the modern applications or sustainability implications of Ming-style design.
Pulleyblank et al. (2020)	Discuss the significance of Ming-style	Highlights the cultural importance of	May not extensively cover the contemporary

	furniture in Chinese cultural heritage and its preservation efforts.	Ming-style furniture and its intangible heritage designation.	adaptations or sustainability aspects of Ming-style design.
Rong & Wei (2018)	Explore the artistic and cultural significance of Ming-style furniture and its influence on modern design.	Provides insights into the enduring appeal and cultural symbolism of Ming-style furniture.	Might lack detailed analysis on contemporary applications or sustainability considerations.
Pedro et al. (2019)	Examine the emergence of Chinese design styles and their impact on contemporary interior design.	Offers a broad perspective on the evolution of Chinese design and its influence on modern aesthetics.	May not delve deeply into specific aspects of Ming-style furniture or its sustainability implications.
Akama et al. (2020)	Investigate the intersection of traditional Chinese design philosophy and contemporary design principles.	Provides insights into the philosophical underpinnings of Chinese design and its relevance today.	May not provide detailed analysis on specific design elements or sustainability considerations.
Cheng et al. (2021)	Discuss the role of traditional culture in China's progress and its influence on industrial design.	Offers perspectives on the cultural significance of Chinese design and its contribution to progress.	May lack specific analysis on Ming-style furniture or its contemporary relevance.

3. Methodology

The present study is a quantitative research, adopting a virtual reality (VR) application to analyze the influence of user satisfaction to Ming-style furniture design. The research design will be described including the selection of participants, the data collect procedure and the analytical technique used to assess the relationship between independent variables and dependent variable as shown in the equation below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \epsilon$$

The participants of this research are 385 users of the Ming-style furniture among the residents in Suzhou, China chosen through randomized sampling method. Suzhou, a city famous for its abundant cultural deposits and as the birthplace of the traditional Ming-style furniture, is regarded as a primary location where huaren of different backgrounds and experiences in furniture design are accumulated. It is expected that, by selecting a relatively large size of the population, it provides a wide range of the interest or and users of the Ming-style furniture to examine.

Administration of a selection of participants is conducted by way of an online survey instrument used to collect data. The survey morbidity is accomplished by questioning participants on all four of the way they were feeling on the day of answering and on their overall experiences with decisions concerning satisfaction, realism, comfort, aesthetics and overall design experience. To this effect, a lizard scale was employed in which the participants reported their levels of agreement with statements concerning the

user's perceptions and experiences of all the four contexts within the Ming-style furniture design. Because the responses to a survey instrument provide numerical data, a well-constructed instrument was created to ensure clarity, comprehensiveness, and relevance to the research objectives and to enable robust data collection and analysis.

Once data collection has concluded, we will employ Statistical Package for the Social Sciences (SPSS) to analyze and interpret the data. Descriptive statistics such as means and standard deviations will be computed to summarize respondents' ratings on each survey item, providing insights into the distribution and central tendencies of responses. Inferential statistical techniques such as Analysis of Variance (ANOVA) and regression analysis will be used to test the relationships between independent and dependent variables and examine to what extent design methods, experience level, furniture complexity and feedback mechanism predict user satisfaction in VR-mediated Ming furniture design contexts.

4. Findings

The following Cronbach's Alpha coefficients from the table are displaying the internal reliability of the scale in the study; Design Method, Experience Level, Furniture Complexity, Feedback Mechanism, and User Satisfaction. Cronbach Alpha assesses the internal consistency of a scale, with a value closest to 1 illustrates the internal consistency of the scale is higher. In this context, every variable shows strong internal consistency by having the coefficients as each are .898 to .913, etc. This high number shows that all the items within each variable measured consistently with a single underlying construct. Thus, measures for the design method, experience level, furniture complexity, feedback mechanism, and user satisfaction were adequate for the reliability of the study, results in increasing the study of the internal reliability.

Table 2. Reliability

	Cronbach's Alpha
Design Method	.913
Experience Level	.903
Furniture Complexity	.898
Feedback Mechanism	.906
User Satisfaction	.898

From analyzing the correlation coefficients, one can find several interesting facts about the variables. In general, with the increasing of one variable, all other variables increase as well. There is a consistent negative correlation among the variables, which suggests that they are connected, and influence each other. Specifically, from 0.625 to 0.754, all factors have a positive correlation of p-value<0.01(2-tailed).

The strongest correlation was found between Feedback Mechanism and User Satisfaction (r = 0.754), indicating that both are strongly and positively related. This demonstrates that as VR provides immediate, detailed feedback to students, their satisfaction level increases. The importance of feedback in VR mediated design environments may be due to its effect on users' perceptions and experiences. By providing feedback to students in real-time, users have increased their interaction in the creative and satisfied with the process and outcomes of design activities.

Moreover, Experience Level is positively and strongly correlated with all dependent variables, ranging from 0.665 to 0.732, indicating that as individuals become more expert with using VR interfaces, they are more satisfied, engage with more complex models of furniture, and receive feedback mechanisms that are more effective. Conversely, novice users may face difficulties navigating virtual reality environments, comprehending complex furniture designs, and making use of feedback, which may shape their satisfaction level.

The correlations that are positive between Design Method, User Satisfaction, and Furniture Complexity are pointed to the fact that these variables are correl ated. If thereof on the occasions in which a designer can go into a virtual take on is to go into a virtual take on a young I'm bike Ming-style furniture having a quite a bit of conversation in a process of interaction, in interact with complex furniture scenes and span that could experience a higher level of satisfaction, whether is being conducted in that process or being

conducted in the encore. And so it seems that are VR technologies have valuable tools to enhance creativity and efficiency, and also enhance the user's satisfaction in the particularly in particular in its complexity.

Table 3. Correlation

		Design Method	Experience Level	Furniture Complexity	Feedback Mechanism	User Satisfaction
Design Method	Pearson Correlation	1	.696**	.689**	.625**	.657**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	385	385	385	385	385
Experience Level	Pearson Correlation	.696**	1	.726**	.665**	.732**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	385	385	385	385	385
Furniture Complexity	Pearson Correlation	.689**	.726**	1	.726**	.737**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	385	385	385	385	385
Feedback Mechanism	Pearson Correlation	.625**	.665**	.726**	1	.754**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	385	385	385	385	385
User Satisfaction	Pearson Correlation	.657**	.732**	.737**	.754**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	385	385	385	385	385

**. Correlation is significant at the 0.01 level (2-tailed).

The coefficient pertaining to Design Method is 0.101, implying that user satisfaction is rising by 0.101 units for every unit increase in the use of VR simulations in the design process. Similarly, Experience Level exhibits a coefficient of 0.271, implying that user satisfaction is increasing as users become more expert with VR interfaces.

Moreover, both Furniture Complexity –with a coefficient of 0.210– and Feedback Mechanism contribute with a coefficient of 0.354– in a positive and significant way, that is to say that as the furniture designs are more complex and the feedback mechanism is more effective, the user's satisfaction increases.

Beta coefficients offer insight into how important each of the independent variables is in predicting user satisfaction while holding the effects of the other variables constant; the Design Method, Experience Level, Furniture Complexity, and Feedback Mechanism exhibit positive standardized coefficients (betas) from 0.096 to 0.358, indicating the strength and direction of the association between each independent variable

and user satisfaction after standardizing the variables so that their relative effects can be compared. In order of importance to user satisfaction, feedback mechanism has the greatest impact, with a beta coefficient of 0.358. From this outcome, the authors conclude that the promptness and effectiveness of feedback mechanisms are decisive for users' experiences and perceived value in VR-mediated design environments. Experience Level follows secondly with a beta coefficient of 0.274, indicating the importance of users' expertise in interaction with virtual design interfaces and complex tasks. Furniture Complexity and Design Method "only" have smaller beta coefficients of 0.212 and 0.096, respectively.

Table 4. Regression Analysis

		Coefficients[a]				
	Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	1.204	.601		2.004	.046
	Design Method	.101	.046	.096	2.213	.027
	Experience Level	.271	.046	.274	5.916	.000
	Furniture Complexity	.210	.048	.212	4.331	.000
	Feedback Mechanism	.354	.043	.358	8.137	.000

a. Dependent Variable: User Satisfaction

This fact tells users that these two factors are not as important as Feedback Mechanism or Experience Level. Feedback Mechanism alone predicts the most variance, so it is the strongest factor. From greatest to least, Feedback Mechanism is the most important independent variable as shown in figure below:
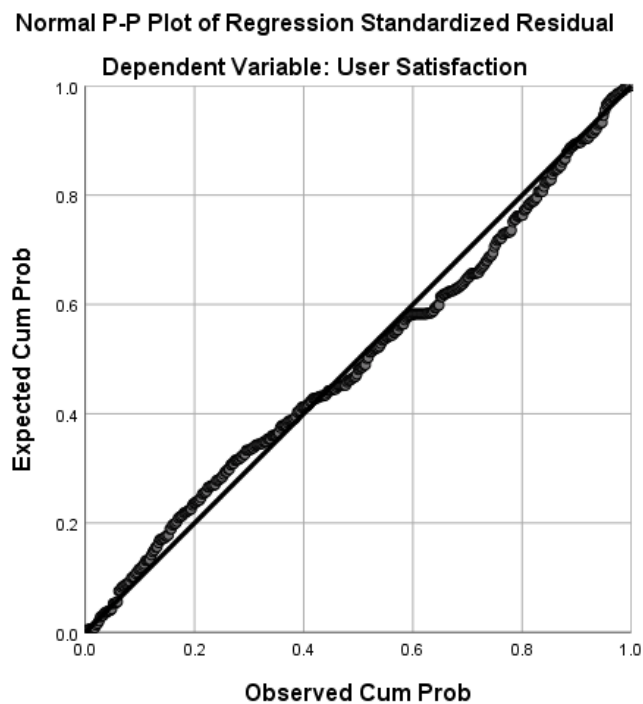
Figure 2. Regression Plot

5. Discussion and Conclusions

Upon analyzing the data, it became evident that there was a significant positive correlation among all of the independent variables, including Design Method, Experience Level, Furniture Complexity, and Feedback Mechanism, and user satisfaction. This finding implies that all of the variables have a logical relationship with each other, indicating that each of them have equal effect on influencing how users perceive and experience in virtual reality-mediated design environment. The most prominent correlation was discovered to be between Feedback Mechanism and User Satisfaction, which represents the significant role of well-timed and informative feedback mechanism on reinforcing user engagement and satisfaction rates.

The results of the regression analysis indicated that the most influential predictor variable of User Satisfaction was found to be Feedback Mechanism, followed by Experience Level. These results provide strong implications for the necessity of a testing ground for impromptu VR design platforms enabled with seamless and responsive user feedback mechanisms, as well as the importance of users' expertise in manipulating virtual interfaces and dealing with complex design tasks [38]. In addition to that, despite the fact that Design Method and Furniture Complexity were also contributors toward User Satisfaction statistically, their influences were relatively less extensive compared to Feedback Mechanism and Experience Level.

In this research, critical factors influencing user satisfaction in VR-mediated Ming-style furniture design were investigated. It is found that design method, experience level, furniture complexity and feedback mechanism have significant positive effect on users' satisfaction, the proposed hypotheses are verified. The results of this study offer insights into optimizing design process and user experience in virtual space by exploring the relationship between these factors and users' satisfaction in virtual reality, further re-expanding the knowledge of design and virtual reality. Results of study contribute to both theory and practice. The findings of this study can be used to help understand the user satisfaction on the VR-based Ming-style furniture design platform. The practitioners can get useful information that could guide the development of user-centered design practice of sense of feedback, by construct speculation advanced. The literature of User-centered design provides the principals of system designing, but lack of practices that product design. Study results also can offer intuitive performance and feedback for the furniture product design in VR platform, if for some objects satisfaction is low, designers could be alerted then meetings design flaw. Particularly for those affect users' satisfaction multiple research factors, designer can be solved through collaborative feedback design practice.

Further excavation into the intricate dynamics of VR-based Ming-style furniture design is crucial, specifically surrounding user engagement and creativity. Creating user feedback mechanisms that correspondingly operate with an interactive experience and immersive setting could increase user satisfaction and help to foster an iterative design process. In addition, further research into developing a user-friendly VR interface for designers at all levels of experience could be used, allowing for inclusivity in design environments. Furthermore, an exploration into augmented reality (AR) technology's ability to be combined with VR applications in the efforts to enhance user experience and design visualization merits exploration. By accepting new technologies and continuously constructing a user-centric design, practitioners can elevate the effectiveness and desirability of VR-based Ming-style furniture design, thus enhancing the design process and corresponding user experience altogether.

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