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The Influence of Semantic and Semiotic Features of Furniture Shape Design on Consumer Preference Based on Fuzzy Computing

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Abstract. This study uses fuzzy computing theory to explore the impact of semantic and semiotic features of furniture shape design on Chinese consumers' preferences and provides a possible reference for designers. In the early stage of relevant research on design, an integrated consumer survey is conducted on furniture form design, and the correlation between the semantic and semiotic features of furniture form design and the semantics and symbols preferred by consumers is invested in the early stage of research and development of furniture design. At the same time, linear regression analysis method is used to analyze the correlation of consumer preference based on the semantic and semiotic features of furniture shape design, and the mathematical function relationship is established to predict the variables of consumer preference. This study is helpful to understand consumers' preference for furniture, so as to carry out relevant design, improve consumers' purchase intention, promote the sale of furniture, and thus become a successful design.

Keywords. Fuzzy Computing, Furniture shape design, Semantics, Semiotics, Consumer Preference.

1. Introduction

Fuzzy computing is based on fuzzy set theory, which can simulate the human brain's imprecise and nonlinear information processing ability and is helpful in many application fields.[1] People can generally use "Fuzzy computing" to represent the calculation methods and theories used in Fuzzy application fields such as Fuzzy Inference Systems (FIS), fuzzy Logic, and fuzzy systems. In these systems, fuzzy set theory is widely applied, and other artificial intelligence means are combined. Therefore, in this study, fuzzy computing can effectively deduce consumer preference for furniture shape design, which is also a meaningful combination of mathematics and design at present and has fundamental research significance for future design. It can make the design less ambiguous and more scientific. Then, consumers' preference for furniture shape design is calculated by the fuzzy comprehensive evaluation method, which is a comprehensive

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evaluation method based on fuzzy mathematics. According to the membership degree theory of fuzzy mathematics, this comprehensive evaluation method transforms qualitative evaluation into quantitative evaluation, which uses fuzzy mathematics to evaluate things or objects that are restricted by many factors. It has the characteristics of explicit and systematic results, can better solve fuzzy and difficult-to-quantify problems, and is suitable for solving various non-deterministic problems.

In this study, the fuzzy computing theory is used to study the influence of semantic and semiotic features of furniture shape design on Chinese consumers' preference. In the early stage of furniture research and development, consumers' preference is investigated and the results are integrated. In addition, the fuzzy computing theory is applied to the research of furniture shape design to provide the basis for furniture shape design and development,[2] so that the design is no longer fuzzy and more scientific, and at the same time, it can shorten the development time of furniture design in the early stage, thus extending the furniture market circulation cycle and increasing the possibility of design success.

2. Research Background and Theoretical Basis

Due to the current economic expansion, market competition is becoming more and more fierce, and consumers' purchase desire for furniture is also changing, which is directly related to the shape design of furniture. The external shape design of furniture directly affects the desire of consumers to buy, and consumers' preference for the shape design of furniture has also become important. On the other hand, the early stage of product development has become an essential means to enhance the value of products; through the early stage of consumer preference research, one can more accurately grasp the direction of furniture external shape design. Therefore, in today's fierce market competition, in the process of furniture design research and development, consumers should be fully investigated in the early stage of design, fully understand consumer preferences, market research should occupy an important position. On the other hand, designers should learn product development and design under the premise of understanding consumers' preferences and needs for the external shape design of furniture. Enterprises can improve consumers' purchase willingness through consumers' perceived value of products, achieve product purchase goals, and improve their own market competitiveness.

2.1. Fuzzy Computing Theory

Fuzzy computing involves obtaining the final output from the input of several control variables according to fuzzy rules. In life, the output is often determined based on the input of several variables and a set of rules of thumb expressed in natural language. This is a fuzzy calculation process.[3] As in real life, we often decide the air conditioner's temperature in the summer according to the temperature and humidity. The goal of fuzzy computing is to use as few resources as possible to complete the goal under the given accuracy and reliability of computing requirements. The biggest feature of fuzzy computing is that the time required for calculation is limited by both the size of the data set and the required precision. Reducing the accuracy can speed up the calculation, which can be as accurate as possible according to the existing capacity of the machine, and at

the same time, when the data volume rises, it is not necessary to increase the machine, but only need to reduce the calculation accuracy.

Fuzzy computing is generally suitable for two situations: (1) complex nonlinear problems without complete mathematical models, and empirical rules can be used to obtain the final result without knowing the model at all. (2) In addition, fuzzy computing can be combined with other intelligent algorithms, and at the same time, it can realize the complementary advantages, and introduce the way for the machine and its control in the fuzzy aspects of human recognition, decision and understanding, and increase the scientific analysis.

In this study, furniture shape design's semantic and semiotic features impact consumer preference, while the reference and application of semantics and semiotics of design essence are vague. However, according to Einstein's relativity theory, the impact of anything is based on evidence. Similarly, when the design semantics are determined at the beginning of the design, the design semantics are determined when the theme is determined. What kind of symbols can better express design semantics? At the same time, what impact do the semantics and semiotics of furniture shape design have on consumers? The researchers used fuzzy calculations to survey consumers to reach their conclusions.

2.2. Semiotics Theory

Semiotics is a controversial historical semiotics: Since the late 1930s, designers inspired by Morris have applied the field more interactively to design, and although the number of studies on semiotics has now increased, scholarly contributions to the field have been episodic rather than systematic, and only in a few cases have the semiotics of design projects been accurately studied.[4]

Looking back at the history of modern design development, it can be found that the so-called "crisis of meaning" occurred in Western design in the 1950s. The emergency reconstruction after World War II was the background to this historical period, so the global spread of the post-World War II "international style" was inevitable. However, following the emergence of many undifferentiated standardized designs in Western cities.

This phenomenon has given rise to the design thinking circle, which questions the theoretical principles proposed by the first generation of design masters. The new design concept has a fundamental theoretical point: the different reactions of individuals to products. Since individuals observe products from different perspectives and adhere to different viewpoints to evaluate products, the evaluation conclusions need to be consistent.[5] Thus, "meaning" events occur in design. The new thinking trend requires people to pay close attention to this new Angle to explore the design problem, so the design semiotics emerged. From the practical point of view of symbols, the practical study of design semiotics focuses on the relationship between users and audiences generated by design as a symbolic system.

However, most of the above literature deals with the dimensions of hermeneutics and cognitive psychology, and there needs to be a summary or lack of design research with detailed and applied design methods. The design semiotic literature is more limited than the semiotic design literature, and the relationships between the literature need to reveal interdisciplinary research processes. However in previous research, the relationship between time-progressive research and cross-sectional study is mainly focused on case analysis and applying semiotic thought rather than discussing product design methods.(cross-sectional study is a comparative study of groups of different collectives at the same point in time. This method mainly focuses on the similarities and

differences between different individuals, and reveals the differences and similarities between different groups by comparing the same or different variables of different groups, so as to explore the universality and regularity of social phenomena. This research method is good at horizontal comparison and can be used to study the popularity, prejudice and values of certain kinds of problems in different groups.)

2.3. Semantics Theory

Semantics is the study of language; a sentence is composed of different words, and the relationship between the words constitutes the sentence's meaning. The essence of semantics is to study the relationship between its words or contexts, that is, the sentence itself, to reveal what kind of meaning. In the design community, this "relationship" is applied to the design of products, what is the meaning of designing a product, what is the effective communication with consumers, that is, how to "dialogue" with consumers to produce "product semantics." [6]At the same time, its theoretical structure started from the design semiotics of Ulm School of Design in Germany in 950. It can be traced back to the semiotics of Charles and Morris in the new Bauhaus School in Chicago.[7] Semantics is a more specific continuation of semiotics. At the same time, Morris's theory pays more attention to the essence of meaning attributes.

As mentioned before, the essence of product semantics focuses on effective communication between people and things, that is, what does the product convey to the consumer? Function? Culture? In other words, the product's internal structure is revealed or hinted at to the user through the visual language of the product material, shape, structure, color, texture, etc., so that the product's function is evident.[8] The human-machine interface is simple and easy to understand to remove the user's confusion about the operation of the product and to design the shape with a more precise visual image and more symbolic significance. Convey to the user more cultural connotation, but also produce an exciting lifestyle to achieve the harmony and unity of people, machines, and the environment.

On the other hand, the meaning of product semantics includes extensional semantics and intensional semantics. Extensional semantics is the basis of product existence and the most direct semantic transmission, which is more intuitive, more rational, and more logical than the connotation of product modeling. While intensional semantics is premised on extensional semantics, the two are interrelated.

3. Questionnaire data processing and fuzzy calculation statistics

In this study, according to the semiotic and semantic features of furniture shape design, the fuzzy symbols and semantics favored by Chinese consumers belong to the category of human psychological cognition, which is fuzzy, subjective, and uncertain. Therefore, it is difficult for designers to describe and express consumers' preferred semantics and symbols scientifically. However, in the research, Likert scale can be used for declarative expression, while numbers can be used for specific division expression, as follows:

This scale is expressed by the following statements: strongly agree, agree, not necessarily, disagree, strongly disagree five kinds of answers, respectively recorded as 5, 4, 3, 2, 1. The total score of each respondent's attitude is the sum of his answers to each question, and this total score can indicate the strength of his attitude or his different states on this scale.[9]

Therefore, in this study, the method of fuzzy calculation is used to divide the questionnaire into five levels. Firstly, fuzzy computing theory is used to process the preference data generated by Chinese consumers according to the semantic and semiotic characteristics of furniture shape design, and then related research and analysis are carried out.

In the fuzzy rule step, the triangular fuzzy points are attached to these five statements: "strongly agree, agree, not necessarily, disagree, strongly disagree," then these become the expected semantic variables, and B represents the triangular fuzzy number. Define S= (0, 0, 1), (0, 1, 2), (1, 2, 3), (2, 3, 4), and (3, 4, 5) to represent these five statements respectively, then the defuzzification formula for S is as follows:

$S=(m,n,o),\ W_S=(m+2n+o)/4$

Starting from the fuzzy descriptive statistical equation, the following equation can be derived:

Fuzzy Semantic Mean=$[\sum_1^n(m+2n+o)]/4N$ *(N= Number of participants)*

The above calculation formula is used to carry out questionnaire investigation and analysis.

4. Statistics and analysis of research results

According to the survey results on the semantic and semiotic features of furniture shape design, semantics, semiotics, and interaction impact consumers' purchase preferences. Table 1 shows item 17: "Consumers like furniture that has symbolic meaning and conveys semantics." It is the most significant, and the fuzzy semantic value is 4.4205. At the same time, item 11, "Consumer concerns about furniture size." It is the least significant, and the mean value of fuzzy semantics is 3.8562.

Table 1. Questionnaire survey descriptive statistics.

	N	Fuzzy Semantic Mean	Std. Deviation		N	Fuzzy Semantic Mean	Std. Deviation
item11	723	3.8562	.79736	item11	723	3.8562	.79736
item12	723	4.0553	.80836	item12	723	4.0553	.80836
item13	723	4.1245	.83284	item13	723	4.1245	.83284
item14	723	4.0858	.80052	item14	723	4.0858	.80052
item15	723	4.1452	.69997	item15	723	4.1452	.69997
item16	723	4.2254	.72952	item16	723	4.2254	.72952
item17	723	4.4205	.73701	item17	723	4.4205	.73701
item18	723	4.3430	.77614	item18	723	4.3430	.77614
item19	723	4.1411	.73648	item19	723	4.1411	.73648
item110	723	4.2282	.72102	item110	723	4.2282	.72102

The impact of integration and interaction on consumer fuzzy semantics is distinguished according to furniture semantics and semiotic design features, as shown in Table 1. "Consumers like furniture that has symbolic meaning and conveys meaning." If the highest and the mean value of fuzzy semantics is 4.4205, then the fuzzy membership function is u(s):1=(4.42-4.0):(5-4), and the obtained fuzzy membership function is u(s)=0.42. Therefore, the questionnaire value of this study is between "strongly agree" and "more agree," and the ambiguity is 0.42, indicating that consumers prefer furniture that has symbolic meaning while conveying semantic meaning. At the same time, in the experimental research, the quality and comfort of furniture are 4.0553 and 4.0858

respectively, accounting for the middle fuzzy value, so consumers pay less attention to the quality and comfort in the process of buying furniture.

Finally, the linear regression analysis method is used to analyze the correlation of consumer preference for the semantic and semiotic features of furniture shape design, and the mathematical function relationship is established to predict the perceived value variables. (Z_1, Z_2, Z_3) are the features of semantic and semiotic design, that is, semantics, semiotics, and interaction, respectively, and they are independent variables. (C) Fuzzy semantics take consumer preference as the dependent variable to predict the change of consumer perceived value over time. The resulting time series regression model is as follows:

$$C = m + n_1 Z_1 + n_2 Z_2 + n_3 Z_3$$

Where C is the prediction of consumer preference; m is an additional constant; Z_1 (semantics), Z_2 (semiotics), and Z_3 (interactions) are predictors; n_1, n_2, and n_3 are linear slope ratios.

In the linear regression model, the result shows that G2 =.990; Adjusted G2 =.989; F (3,718) =21648.038; p=.000. As shown in Table 2 and Table 3. Figure 1 shows the scatter plot of consumer preference predicted by linear regression analysis of furniture semantics and semiotic design features.

Table 2. Linear regression analysis

G			
Model	**G**	**G^2**	**Adjusted G^2**
1	.995(a)	.990	.989

Independent variables: differentiation, integration, interaction
Dependent variable: consumer preference

Table 3. Linear regression analysis

			Mean		
Model		**df**	**Mean Square**	**F**	**Sig.**
1	Regression	3	38.281	21648.038	.000(m)
	Residual	718	.003		
	Total	711			

Independent variables: differentiation, integration, interaction
Dependent variable: consumer preference

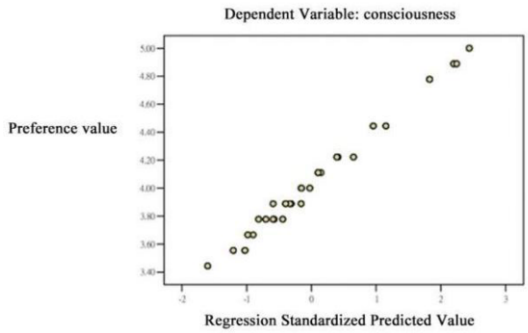

Figure 1. Regression Standardized Predicted Value

5. Conclusions and recommendations

In the current fierce market competition, in the early stage of product development, relevant research for consumers' needs for furniture can significantly shorten the product research and development cycle while being more targeted, and the possibility of product success is significantly increased.[10] By understanding the preferences of consumers, we can choose the semantics and symbols suitable for consumers to carry out relevant designs, increase the sales of furniture, and increase the purchase willingness of consumers, to achieve the final goal of furniture sales. This study provides a reference for designers when designing furniture. According to the study of fuzzy computing, the semantic meaning, symbol, and interaction of furniture are positively related to consumer preference in furniture shape design. At the same time, consumers do not care about the size of furniture but prefer furniture that has symbolic meaning and conveys semantic meaning.

To sum up, it is recommended that designers integrate the semantics and symbols recognized by consumers into the design process during the furniture design development period to improve consumers' purchase intention, shorten the design cycle, and thus improve the circulation cycle of furniture in the market.

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