Hindawi
Scientific Programming
Volume 2022, Article ID 9273429, 13 pages
https://doi.org/10.1155/2022/9273429

Research Article

Research on Customer Perceived Value Evaluation of New Chinese-Style Clothing Based on PSO-BP Neural Network

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Received 4 August 2022; Accepted 21 September 2022; Published 11 October 2022

Academic Editor: Lianhui Li

In the current era that consumers pursue personalized experience, in order to optimize the customer experience of new Chinese-style clothing products and improve the evaluation procedures of new Chinese-style clothing products, based on the theory of customer perceived value, this paper constructs the evaluation index and evaluation model of new Chinese-style clothing customer perceived value. This study is divided into three stages: firstly, through literature research and interview, thirty-seven elements of the evaluation index of customer perceived value of new Chinese-style clothing are defined; secondly, through questionnaire survey and exploratory factor analysis, seven dimensions of the evaluation index of the customer perceived value of new Chinese-style clothing were extracted, which were cultural and educational value, aesthetic value, creative value, green value, engineering value, social value, and quality value, respectively; thirdly, we propose a PSO-BP neural network to evaluate the customer perceived value of new Chinese-style clothing, and we choose twenty-two and eight new Chinese-style clothing as training samples and test samples, respectively. The experimental results show that the PSO-BP neural network can accurately evaluate the customer perceived value of new Chinese-style clothing, and its error is controlled by 2.5% compared with the traditional BP neural network. The research results show that enterprises can improve the quality of product design through the new Chinese-style clothing customer perceived value evaluation indicators and models, and then improve their sustainable competitive advantage, so as to achieve the sustainable development of the new Chinese-style clothing industry ultimately.

1. Introduction

With the rapid development of China's cultural and creative industries, under the influence of policy guidance, financial support, technology iteration, talent innovation, and other factors, cultural industries represented by new Chinese-style clothing, animation, etc. have gradually become the pillar industries of the national economy, and they play an important role in improving the country's cultural soft power [1]. As far as the new Chinese-style clothing (a design style that grasps the ideological connotation of Chinese style, refines Chinese design elements, and innovates in combination with current materials and technologies) industry is concerned, enterprises continue to strengthen the cultural uniqueness, fashion, and innovation of new Chinese-style clothing products through design, giving product value soul and vitality, and then promoting the sustainable development of the new Chinese-style clothing industry [2]. But from the current market situation, the problem of "misalignment of supply and demand" of products is still a bottleneck that plagues the sustained and healthy development of the new Chinese-style clothing industry. Therefore, from the perspective of consumers, accurately grasping the changing consumer needs and consumption concepts of customers is of great significance for the development of the new Chinese-style clothing industry [3].

Modern product design is a process of a series of activities that seek design solutions to consumer demand [4]. In this activity, a crucial link in the product system analysis and evaluation is an essential basis for product design decisions. The so-called evaluation generally refers to the behavior of determining the attribute of an object according to a clear goal and turning it into the subjective utility (the degree of satisfying the requirements of the subject), that is, the process of defining the value. In this process, we should compare the evaluated object with a particular object to determine the value of the object [5]. However, looking at the new Chinese-style clothing industry, it is found that there is no unified product evaluation index and method for China. Most of the enterprises determine the final design of products based on the subjective empirical assessment of the products from the designer's perspective, and the evaluation process often has a certain degree of one-sidedness and uncertainty. Therefore, when faced with the market reality that the personalized demand is prominent and the competition is becoming more and more fierce, in order to achieve the sustainable development of new Chinese-style clothing enterprises and industries, it has become an urgent problem for relevant enterprises and academia to build new Chinese-style clothing product value evaluation indicators guided by customer expectations, and to find scientific and reasonable product value evaluation methods, improve the design quality of new Chinese-style clothing products, and alleviate the contradiction between supply and demand.

Given this, this paper firstly introduces the customer perceived value theory. It combines the characteristics of the new Chinese-style clothing products with in-depth interviews and questionnaires with relevant consumers to build a system of measuring indicators of customer perceived value of new Chinese-style clothing products. The customer perceived value theory has received much attention since its inception and is often used to explain customers' subjective preferences and consumption behavior in specific situations. Based on this, this paper further incorporates the BP neural network method for evaluating natural case products. As an interactive evaluation method, the BP neural network can avoid the imprecision of artificially determined evaluation index weights and make the results more realistic. However, the traditional BP neural network also suffers from poor fault tolerance, the algorithm tends to fall into local minima, slow convergence, and instability in learning. To solve the above problems, this paper constructs a BP neural network evaluation model based on the particle swarm optimization algorithm. It uses the particle swarm optimization algorithm to obtain the optimal weights and thresholds for each layer of the BP neural network to further evaluate the consumer perceived value of the new Chinese-style clothing. Combined with the customer perceived value measurement index together, it will provide a more comprehensive, objective, and accurate reflection of the level of customer perceived value of the new Chinese-style clothing products, which will support the optimization of product design and the sustainable development of the company.

2. Literature Review

2.1. Sustainable Competitive Advantage and Customer Perceived Value. As an important part of the sustainable development strategy of enterprises, the sustainable competitiveness of enterprises is not only a strong support for the development of enterprises, but also the only way for the sustainable development of enterprises. Therefore, sustainable competitive advantage has always been the topic of concern of enterprise strategy theory [6, 7]. Porter [8] first mentioned sustainable competitive advantage when discussing the company's long-term competitive advantage to obtain low cost or differentiation, and pointed out that the sustainable competitive advantage of an enterprise comes from the value it creates for customers that exceeds its cost, which ultimately depends on the value it can create for customers. Barney [9] proposed that one of the necessary conditions for obtaining the unique strategic resources of sustainable competitive advantage is that the resources are valuable; that is, they can enable enterprises to increase customer value and improve their business performance. Woodruff [10] also clearly pointed out that customer perceived value is the source of competitive advantage. Although there are great differences in the theoretical assumptions about sustainable competitive advantage and the various theoretical schools of its origin, there is a consistent understanding of the premise of obtaining sustainable competitive advantage: the degree of customer recognition of the value of enterprise products or services, and the customer perceived value determines the sustainable competitive advantage of enterprises.

The recognition and research of value from the perspective of customers began in the 1990s. For the dimensional measurement of customer cognitive value, it has also changed from the initial single dimensional measurement to multidimensional measurement. In the early days of the theory, Zeithaml [11] referred to perceived value as the subjective value that the user has in mind after measuring the gain or loss. Simultaneously, Monroe [12] defined perceived value as the perceived quality or benefit that the customer gets from the product, as opposed to the sacrifice made by the price paid, etc. The above definitions of value in trade-offs between the "get" and "give" items are seen in marketing applications due to trade-offs between quality and price and are one-dimensional value judgments. In subsequent theoretical studies, Bolton and Drew [13] argued that viewing value as a trade-off between quality and price was too simplistic. Sheth et al. [14] argued that measuring perceived value as a single construct would lack validity and therefore proposed five dimensions of customer perceived value: functional value, social value, emotional value, epistemic value, and conditional value.

With the shift in the consumer market in recent years, many clothing companies have shifted from the traditional external competitors or internal resource conditions to the customer, which is fundamental to business survival and development. Under this background, the theory of customer perceived value is widely used in the research field of clothing product design. For example, Yan et al. [15], Yu et al. [16], and Li et al. [17], based on the theory of customer perceived value and combined with the characteristics of Internet distribution, built a measurement model of customer perceived value of online clothing customization; Chen et al. [18] took the value perception of children's clothing safety as the research object and developed a set of children's clothing safety perception measurement scale including 3 dimensions and 27 measurement items; Chi [19] used a multidimensional consumer perceived value model to explore the characteristics of consumer expected value of environment-friendly clothing, including social value, emotional value, quality value, and price value; Zhou et al. [20] took men's suits as the product object and discussed the design optimization scheme of men's suits by establishing a model between users' perceived image, suit design features, and user preferences. Through the above literature collection and analysis, the customer perceived value theory has been applied to different clothing situations, including clothing customization, green clothing products, and men's clothing. However, there is still a lack of research on new Chinese-style clothing products. The constituent elements of customer perceived value differ for different clothing products. In particular, the new Chinese-style clothing products have distinctive characteristics such as spiritual and cultural categories, aesthetic forms, and cultural symbols, which are different from the general clothing products. Therefore, it is of practical significance to study the connotation of customer perceived value of new Chinese-style clothing.

Based on the above analysis, as a subjective feeling in the customer's heart, the customer's definition of perceived value is subjective, complex, and multidimensional. Therefore, this paper will refer to the functional value, social value, emotional value, epistemic value, and conditional value proposed by Sheth et al. [14] as the basis of the new Chinese-style clothing customer perception value evaluation study.

2.2. BP Neural Network and Particle Swarm Optimization. BP neural network (back-propagation neural network), also known as error back-propagation neural network, is one of the most representative and commonly used artificial neural networks, especially in nonlinear problem-solving. The structure of the BP neural network is divided into input layer, hidden layer, and output layer. Its structure is shown in Figure 1. The process of the BP neural network can be divided into two stages: forward propagation and backward propagation. In forward propagation, the input signal is processed from the input layer through the hidden layer and then passed to the output layer, with the nodes in the previous layer only affecting the nodes in the next layer. Suppose the output layer does not get the desired output. In that case, it is transferred to the error back-propagation process by adjusting the weights and thresholds of the prediction errors to achieve a BP neural network prediction output with a good fit [21]. In Figure 1, x represents the input and y represents the output. $f1$ is the activation function from the input layer to the hidden layer, and $f2$ is the activation function from the hidden layer to the output layer. w_{ij} and w_{jk} represent the weights of the neural network.

From the above analysis, it can be seen that customer perceived value has the characteristics of subjectivity and complexity, and its actual evaluation belongs to a typical nonlinear problem. If traditional product evaluation methods such as AHP and fuzzy comprehensive evaluation are used, it is easy to cause distortion and bias of evaluation results by setting the premise for the operation of the linear

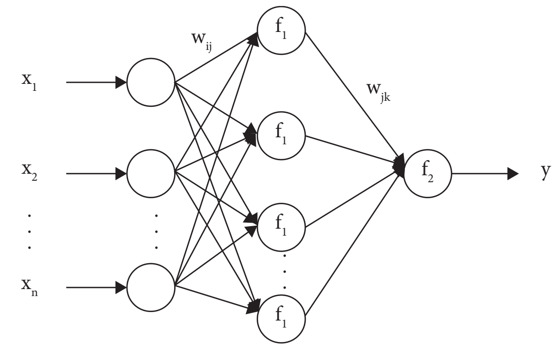

Figure 1: Structure of the BP neural network.

relationship between evaluation indexes. Therefore, it provides a certain theoretical basis for this paper to apply the BP neural network to evaluate the customer perceived value of new Chinese-style clothing. However, before starting training, the BP neural network randomly initializes the weights and thresholds of each layer to the value between [0, 1]. This kind of random initialization without optimization often slows the convergence speed of the BP neural network and easily makes the result nonoptimal [22]. As a swarm intelligence optimization algorithm, the particle swarm optimization (PSO) algorithm can map the weights and thresholds in the BP neural network to particles in the PSO algorithm, and update the speed and position of particles through iteration, so that individuals can find the optimal solution in the solution space [23]. The specific principle of PSO algorithm has been described in detail in Ref. [24], so it will not be repeated here. Therefore, this paper introduces the PSO algorithm to optimize the initial value and threshold, so as to significantly improve the training and modeling speed, stability, and solution accuracy of the BP neural network.

3. Construction and Validation of the Evaluation Index of Customer Perceived Value in the New Chinese-Style Clothing

In the analysis of this section, this paper aims at constructing the evaluation index of new Chinese-style clothing customer perceived value, and verifying the reliability and validity of the evaluation index. The specific research steps are divided into three stages: the first stage is to collect data by means of literature analysis and consumer questionnaire interview, and then sort out and code the interview contents through the research team to define the evaluation element factors; in the second stage, a large-scale questionnaire survey was conducted based on different gender, age, and educational background. Using the exploratory factor analysis method, the main aspects of the new Chinese-style clothing customer perceived value evaluation index are extracted, and based on this, the new Chinese-style clothing customer perceived value evaluation index scale is developed; in the third stage, reliability and validity analysis is used to verify the stability and predictability of the new Chinese-style clothing customer perceived value evaluation index.

3.1. Exploring the Element Factors for Evaluating the Customer Perceived Value of New Chinese-Style Clothing. To determine the element factors that can be used to establish the evaluation index of new Chinese-style clothing customer perceived value, this paper uses literature analysis and interview method sequentially and gives the interview results to the research group for coding and screening to determine the element factors.

First of all, this paper collects and refers to the research results of Yen et al. [25]'s cultural fashion design measurement index, Liu et al. [3]'s new Chinese-style clothing purchase intention scale based on the product quality theory, Kim et al. [26]'s clothing design evaluation standard scale based on consumer perspective, Yu et al. [16]'s men's shirt custom customer perceived value evaluation scale, Chi et al. [19]'s environment-friendly clothing consumer perceived value scale, and Ahn et al. [27]'s 6-dimensional clothing product quality measurement scale oriented to customer demand. According to the above research results, an interview questionnaire was designed. The interview questionnaire is combined with the context of new Chinese-style clothing products and focuses on referring to various cases listed in the collected literature.

Secondly, this paper uses the interview method to investigate the current situation. To obtain more practical consumption demand and value preference for new Chinese-style clothing products, the author obtained a group of interviewees through a random survey, online forum invitation, and snowball recommendation. After thoroughly considering factors such as age, gender, occupation, education level, and user experience with new Chinese-style clothing products, the author finally selected 41 interviewees from different situations. The selected subjects are between 20 and 59 years old, covering the old, middle-aged, and young generations; the number of men and women in gender tends to be half (22 women and 19 men) to reduce the impact of gender factors. They have more than 3 years of experience in using new Chinese-style clothing products, and the longest is as long as 10 years. Their occupations include college students and those who have participated in the work.

The questionnaire's content is divided into three parts, with four questions in each part, making 12 questions. The first part is an interview with the basic information content of the respondent, in which the respondent explains the content of the case, the reason for purchase, and the occasion of wearing. The second part is an in-depth interview with the respondent. The respondents are encouraged to deepen further their thinking regarding the five dimensions of consumer perceived value: functional value, emotional value, social value, epistemic value, and conditional value. In the third part, in order to obtain valid interview results, we use some consumption cases (choice between well-known and ordinary brand products, different preferences between green and ordinary products, etc.) to stimulate the respondents to reflect on whether they have additional feelings beyond the previous interview. Given the impact of the current epidemic, this paper uses a combination of online and offline interview formats.

In the sorting and analysis of qualitative data, the primary focus is on coding. Coding is a systematic method of extracting data. In the process, data are analyzed and combined according to themes, concepts, or categories. The main procedures include three steps: open coding, axial coding, and selective coding [28]. After the interview and data collection, this paper commissioned a research group composed of experts and academics (a total of five people, including two professors and three associate professors) to conduct open coding first; that is, the research group extracted important information according to the interview content and integrated the obtained information into a unified category. Secondly, based on the understanding of the research topic, the research group linked all categories according to their internal organic associations (i.e., axes), found out the spindle code and named it, and finally obtained the element factors that may affect the evaluation of the perceived value of new Chinese-style clothing. Since the coding in this paper is mainly for inductive results, it is not within the scope of discussion to pay attention to the selective coding of text storylines, so this part is omitted [29]. In the end, the analysis yielded 37 factors such as Convey cultural meaning, Show the charm of regional culture, and Traditional natural fabrics (as shown in Table 1).

3.2. Extracting the Dimension of Customer Perceived Value Evaluation Indicators for New Chinese-Style Clothing. After the first stage of the paper, 37 customer perceived value evaluation factors were coded and calculated. In the second stage, the structures and links between the 37 evaluation factors were identified through exploratory factor analysis. The constructs of the new Chinese-style clothing customer perceived value evaluation indicators were extracted.

Firstly, the 37 element factors from the pretest questionnaire were re-ranked randomly, and each element factor was converted into an item in the questionnaire. Secondly, participants were asked to select the level of agreement with the purchase of the product from a 7-step Liker scale ranging from "strongly disagree" to "strongly agree" on a scale of 1 to 7. The positive sentiments for each item increased as the scores increased. The positive sentiment for each item gradually increases as the score increases, so that the scores can be added up for subsequent analysis. Finally, through exploratory factor analysis, the element factors were analyzed, deleted, or modified to find common factors to be named to extract a suitable index profile for evaluating the customer perceived value of new Chinese-style clothing.

In this paper, the data were collected mainly through online questionnaires, and 253 valid questionnaires were obtained, meeting the sample size requirement suggested by scholars [30]. Among the 253 questionnaires, 132 were completed by women and 121 by men; in terms of age distribution, 27 respondents were aged between 18 and 25 years, 90 were aged between 25 and 32 years, 75 were aged between 33 and 39 years, 40 were aged between 39 and 46

Table 1: List of evaluation element factors.

No.	Evaluation element factor
1	Convey cultural meaning
2	Show the charm of regional culture
3	Positive cultural enlightenment significance
4	Long-lasting and durable performance
5	Comfortable and breathable to wear
6	Convenient for daily cleaning and maintenance
7	Easy to move after wearing
8	Excellent manufacturing technology
9	An overall sense of refinement
10	Exquisite structure
11	Highly textured crafts such as prints and embroideries
12	Compact and beautiful accessories
13	Have an attractive story or moral
14	Have practical functions
15	Bring back fond memories of life
16	Have a sense of glamour
17	Physiotherapy and healthcare fabrics
18	Green textiles
19	Traditional natural fabrics
20	Promote a sense of personal confidence
21	Become more popular
22	Enhance personal image
23	Show personal social status
24	Show professional image
25	Make people feel special
26	Originality or creativity
27	A unique way of dressing
28	Versatility
29	Partial creative design details
30	Variety of matching features
31	Good styling proportions
32	Modern and stylish
33	Harmonious and beautiful color matching
34	Exquisite decoration
35	Exquisite design details
36	Product recyclability
37	Natural dyed fabric

years, and 21 were aged 46 years or above; in terms of education distribution, 32 were with high school education or below, 53 with secondary school or college education, 113 with bachelor's degree, and 55 with postgraduate education.

In statistical analysis, data conforming to normal distribution is the basic assumption and premise of many continuous data comparison and analysis, among which skewness and kurtosis are important normality test indicators [31]. After the collection and collation of the questionnaire, first of all, through descriptive statistical analysis, we can find that the skewness values of 37 element factors are between −0.919 (Product recyclability) and −0.030 (An overall sense of refinement), and the kurtosis values are between −0.543 (An overall sense of refinement) and 0.591 (Convey cultural meaning). The absolute values of skewness and kurtosis meet the verification standards proposed by Kline [32] that the absolute value of skewness is within 2 and the absolute value of kurtosis is within 7. It indicates that the data are normally distributed, which is suitable for exploratory factor analysis and reliability and validity analysis.

Then, in exploratory factor analysis, through the first factor analysis, it was found that the five variable factor loads of Have a sense of glamour, Originality or creativity, Compact and beautiful accessories, Show personal social status, and An overall sense of refinement were not higher than 0.50, so they were eliminated. Then, the data were subjected to a second factor analysis. After the KMO and Bartlett tests, the KMO sampling fitness measure was 0.935 and the Bartlett sphericity test approximate chi-square value was 5456.231, with a significance level of 0.000, indicating that the data were valid and suitable for factor analysis [33, 34]. After passing the check, principal component analysis in factor analysis was continued to extract common constructs, with eigenvalues greater than one as the principle for selecting the number of common factors, resulting in a total of seven major constructs that explained 72.539% of the cumulative variance. Immediately afterwards, the selected conformations were pivoted by the maximum variance pivoting method, resulting in a rotated component matrix (as shown in Table 2).

Finally, the reliability and validity analysis revealed that Cronbach's alpha values of all seven dimensions were higher than 0.7, the average variance extracted (AVE) values of each dimension were greater than 0.5, and the square root values of the average variance extracted were also greater than the correlations with other factors (as shown in Table 3), which verifies that the seven dimensions have good reliability at the same time [35], and it also indicates that the dimensions have good validity [36].

Dimension 1 is mainly composed of five element factors: Convey cultural meaning, Bring back fond memories of life, Show the charm of regional culture, Have an attractive story or moral, and Positive cultural enlightenment. The factor load is between 0.819 and 0.742, and the explained variance is 11.585%. This dimension reflects consumers' pursuit of the emotional cognitive value of new Chinese-style clothing products, but different from the aesthetic value of using product modeling elements as emotional transmission media, dimension 1 emphasizes the attraction of an internal cultural gene of new Chinese-style clothing products, which provides consumers with a unique product impression and cultural attribution through the emotional association of the brain. It also edifies and promotes the spiritual level of consumers, so this dimension is named as the cultural and educational value of the product.

Dimension 2 is made up of five factors: Exquisite design details, Modern and stylish, Exquisite decoration, Good styling proportions, and Harmonious and beautiful color matching. The factor load ranges from 0.787 to 0.705, with an explained variance of 11.449%. This dimension also reflects consumers' pursuit of the emotional perception value of new Chinese-style clothing products, that is, the product shape is used as a medium to convey information through the product shape elements, allowing consumers to form a visual perception of beauty, which in turn gives them a sense of inner pleasure. As the main expression of the product's visual aesthetic features on the consumer's emotions, this dimension is named the aesthetic value of the product.

Table 2: Rotated component matrix.

Dimension	Index	Dimension 1	Dimension 2	Dimension 3	Dimension 4	Dimension 5	Dimension 6	Dimension 7
Cultural and educational value	Convey cultural meaning	**0.819**	0.154	0.201	0.105	0.179	0.145	0.114
	Bring back fond memories of life	**0.777**	0.179	0.084	0.127	0.183	0.184	0.044
	Show the charm of regional culture	**0.771**	0.065	0.203	0.172	0.163	0.083	0.096
	Have an attractive story or moral	**0.766**	0.034	0.099	0.124	0.140	0.103	0.106
	Positive cultural enlightenment significance	**0.742**	0.126	0.141	0.134	0.158	0.198	0.149
Aesthetic value	Exquisite design details	0.145	**0.787**	0.102	0.163	0.134	0.099	0.119
	Modern and stylish	0.140	**0.767**	0.248	0.196	0.231	0.189	0.098
	Exquisite decoration	0.115	**0.764**	0.171	0.088	0.240	0.151	0.061
	Good styling proportions	0.053	**0.754**	0.163	0.170	0.145	0.140	0.068
	Harmonious and beautiful color matching	0.119	**0.705**	0.204	0.129	0.104	0.208	0.222
Creative value	Make people feel special	0.195	0.193	**0.814**	0.199	0.138	0.056	0.099
	A unique way of dressing	0.169	0.197	**0.803**	0.114	0.179	0.178	0.141
	Variety of matching features	0.180	0.171	**0.762**	0.151	0.175	0.238	0.084
	Versatility	0.176	0.175	**0.724**	0.172	0.105	0.022	0.073
	Partial creative design details	0.046	0.124	**0.696**	0.224	0.137	0.128	0.161
Green value	Product recyclability	0.157	0.146	0.208	**0.837**	0.168	0.136	0.119
	Physiotherapy and healthcare fabrics	0.135	0.180	0.154	**0.784**	0.132	0.164	0.082
	Green textiles	0.132	0.279	0.159	**0.781**	0.059	0.091	0.138
	Natural dyed fabric	0.170	0.214	0.185	**0.728**	0.221	0.172	0.121
	Traditional natural fabrics	0.106	-0.013	0.145	**0.641**	0.229	0.047	0.004
Engineering value	Long-lasting and durable performance	0.230	0.242	0.190	0.216	**0.728**	0.219	0.201
	Easy to move after wearing	0.170	0.244	0.223	0.188	**0.717**	0.137	0.123
	Comfortable and breathable to wear	0.215	0.187	0.089	0.129	**0.705**	0.136	0.220
	Have practical functions	0.187	0.149	0.216	0.270	**0.697**	0.146	0.104
	Convenient for daily cleaning and maintenance	0.227	0.176	0.148	0.178	**0.692**	0.237	0.129
Social value	Promote a sense of personal confidence	0.216	0.144	0.115	0.133	0.068	**0.795**	0.078
	Enhance personal image	0.194	0.205	0.177	0.127	0.233	**0.764**	0.094
	Become more popular	0.138	0.221	0.209	0.167	0.165	**0.761**	0.083
	Show professional image	0.144	0.156	0.050	0.124	0.257	**0.693**	0.197

Table 2: Continued.

Dimension	Index	Dimension 1	Dimension 2	Dimension 3	Dimension 4	Dimension 5	Dimension 6	Dimension 7
Quality value	Exquisite structure	0.135	0.128	0.108	0.105	0.173	0.196	**0.827**
	Highly textured crafts such as prints and embroideries	0.146	0.146	0.155	0.119	0.149	0.124	**0.825**
	Excellent manufacturing technology	0.139	0.151	0.178	0.115	0.199	0.054	**0.763**
Explained variance (%)		11.585	11.449	11.419	11.084	10.343	9.156	7.503
Cumulative explained variance (%)		11.585	23.034	34.452	45.537	55.880	65.036	72.539

Table 3: Reliability and validity analysis.

	Cronbach's alpha	AVE	Cultural and educational value	Aesthetic value	Creative value	Green value	Engineering value	Social value	Quality value
Cultural and educational value	0.892	0.601	**0.775***						
Aesthetic value	0.896	0.571	0.396	**0.756***					
Creative value	0.896	0.579	0.456	0.516	**0.761***				
Green value	0.892	0.573	0.434	0.488	0.508	**0.757** *			
Engineering value	0.897	0.501	0.549	0.564	0.529	0.551	**0.708** *		
Social value	0.867	0.569	0.478	0.513	0.456	0.447	0.563	**0.754***	
Quality value	0.854	0.649	0.390	0.415	0.414	0.374	0.503	0.408	**0.806***

Note. Diagonal bold characters (marked with*) are the open root of mean variance extraction (AVE), and the lower triangle is the Pearson correlation coefficient.

Dimension 3 is made up of five factors: Make people feel special, A unique way of dressing, Variety of matching features, Versatility, and Partial creative design details. The factor load ranges from 0.814 to 0.696, with an explained variance of 11.419%. This dimension reflects consumers' quest for knowledge of new Chinese-style clothing products, that is, to satisfy their curiosity, novelty, and desire for knowledge by enhancing the newness of product details in design, matching, function, and wearing style. The elements of the dimension focus on expressing the uniqueness and novelty of the product, hence the name of the dimension as the creative value of the product.

Dimension 4 is composed of five factors: Product recyclability, Physiotherapy and Health Care, Fabrics, Green textiles, Natural dyed fabric, and Traditional natural fabrics. The factor load ranges from 0.837 to 0.641, with an explained variance of 11.084%. This dimension has an interactive value characteristic, reflecting the contextual value of the product. This dimension reflects the desire of consumers who are influenced by the concept of green to satisfy their pursuit of a green and healthy life through products, and is therefore named the green value of the product.

Dimension 5 is mainly composed of five highly relevant element factors, namely, Long-lasting and durable, Performance, Easy to move after wearing, Comfortable and breathable to wear, Have practical functions, and Convenient for daily cleaning and maintenance. The factor load ranges from 0.728 to 0.692, and the explained variance was 10.343%. This dimension reflects the consumers' pursuit of the functional cognitive value of new Chinese-style clothing products and is related to the basic engineering performance of the products. Therefore, this dimension is named the engineering value of the products.

Dimension 6 is composed of the four elemental factors of Promote a sense of personal confidence, Enhance personal image, Become more popular, and Show professional image. The factor load ranges from 0.795 to 0.693, with an explained variance of 9.156%. This dimension reflects consumers' pursuit of the social perception value of new Chinese-style clothing products; that is, it emphasizes the positive role played by the products in consumers' interpersonal and social interactions, and is therefore named the social value of the products.

Dimension 7 is mainly composed of three element factors: Exquisite structure, Highly textured crafts such as prints and embroideries, and Excellent manufacturing technology. The factor load is between 0.827 and 0.763, and the explained variance is 7.503%. This dimension also reflects the consumers' pursuit of the cognitive value of the new Chinese-style clothing product function. However, different from the basic engineering performance of the product, this dimension focuses on the integrity of the product and the functional details, which can enable consumers to produce high-quality images. It needs to be highlighted through detailed design and high-level technology. Therefore, this dimension is named as the quality value of the product.

Through the above analysis, we have obtained seven dimensions containing cultural and educational value, aesthetic value, creative value, green value, engineering value, social value, and quality value, and 32 element factors to build an evaluation index of the customers perceived value of new Chinese-style clothing.

4. Customer Perceived Value Evaluation Model of New Chinese-Style Clothing Based on PSO-BP Neural Network

This paper uses the PSO algorithm to find the optimal initial weight and threshold in BP neural network, and obtains a better neural network model to evaluate the customer perceived value of new Chinese-style clothing.

The specific steps of the experiment are as follows:

(1) Obtain sample data of customer perceived value of new Chinese-style clothing, and preprocess and normalize the data.
(2) Determine the number of nodes in each layer of BP neural network.
(3) Initialize the position and velocity of particles.
(4) Calculate the fitness value of each particle, and find the global extremum.
(5) Update the velocity and position of particles to generate a new particle swarm.
(6) Stop iteration if one of the following conditions is met: the number of iterations reaches the preset value; the error accuracy meets the set value. Otherwise, skip to step 5.
(7) After the iteration stops, the optimal weights and thresholds are put into the BP neural network for training. The BP neural network is trained iteratively until the termination condition is met.
(8) Obtain the BP neural network model optimized by the PSO algorithm.

The construction process of the model in this paper follows as shown in Figure 2.

This section designs a questionnaire based on the new Chinese-style clothing customer perceived value evaluation index constructed in Section 3 and collects the evaluation index data of new Chinese-style clothing products. A BP neural network based on the particle swarm optimization algorithm for the new Chinese-style clothing customer perceived value evaluation model was established. Twenty-two new Chinese-style clothing was selected as training samples and eight new Chinese-style clothing as testing samples, and MATLAB software was used to train and test the neural network examples.

4.1. Data Collection and Preprocessing. The main targets of this questionnaire were undergraduates and postgraduates and their families. College students and their families are potential consumers of new Chinese-style clothing. A total of 50 respondents were selected for the survey.

In this paper, a selection of new Chinese-style clothing products that are currently on the market was selected as the tested products. There are two main processes for their selection:

(1) Selection of new Chinese-style clothing brands: Regarding a combination of indicators such as brand awareness, brand style, the status of the brand's published online performance, and the opinions of experts in the field, the new Chinese-style clothing brands selected for this paper are as follows: ICY, INXX, Bosie Agender, HUSENJI, Hua Mu Shen, BYTEHARE, Nengmao Store, CLOT, LI-NING, ANTA, HLA, PEACEBIRD, SHIATZY CHEN, Mi Shan, and Houxu.
(2) Selection of new Chinese-style clothing products: 1–3 products were selected from the official websites or shopping platforms of the above 15 brands according to their sales index and brand representativeness, and finally, 30 new Chinese-style clothing products were selected as experimental products for this paper.

After determining the new Chinese-style clothing customer perceived value evaluation indexes in Table 3, 30 new Chinese-style clothing products were selected. Through the online survey, 50 subjects were asked to rate the customer perceived value evaluation indexes and the overall design of 30 new Chinese-style clothes. The data of the new Chinese-style clothing products No. 1–22 were used for the training of the neural network, and the new Chinese-style clothing products No. 23–30 were used for testing the neural network. The subjects were shown the front and back pictures and pattern designs of the 30 new Chinese-style clothing products during the survey. In addition to the presentation of the picture information of the garments, the design inspiration, fabric, and accessories were presented.

When comes to statistical data, chance errors, human errors, and sampling errors can lead to outliers. To avoid a minimal number of people with solid subjective emotions or recording errors during the research process, an outlier test needs to be conducted on the scores obtained for each evaluation index and the overall design score for each new Chinese-style clothing product. To prevent outliers in the scoring from influencing the final results, this paper uses Grubbs' test (two-tailed test) to eliminate outliers [37]. The statistic for Grubbs' test (equation (1)) is shown in the following:

$$G = \frac{\left|x_i - \overline{x}\right|}{S}, \tag{1}$$

where x_i is the score of a certain indicator of a new Chinese-style clothing product, $\overline{x}$ is the mean score of the corresponding indicator of the corresponding clothing, and S is the corresponding standard deviation.

After testing, 124 outliers, generally extreme data caused by some subjects' strong subjective emotions on some clothing's indicators, were removed. Appendix A lists the scores of some sample clothing evaluation indicators after removing outliers. The data of the input layer of the BP neural network model are the average of the scores of 50 subjects.

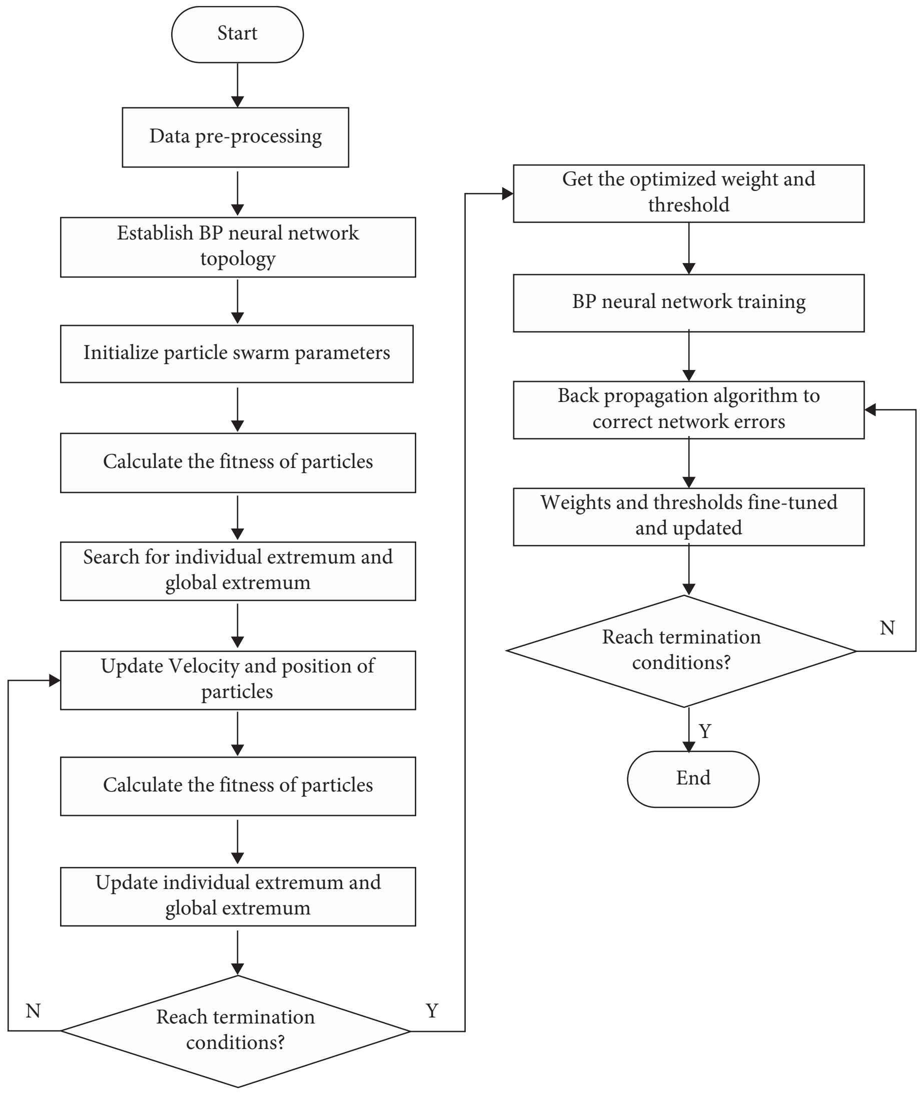

Figure 2: Flowchart of the PSO-BP neural network.

The 32 customer perceived value evaluation indexes data and overall design scores of 30 new Chinese-style clothing are taken as the original data. In order to improve the convergence speed of the BP neural network and the consistency of the results, it is also necessary to normalize the original data. In this paper, the min-max standardization method is adopted, called 0–1 standardization. That is, the original data were linearly transformed. To make the results distributed between 0 and 1, the function is used to process the original data linearly. The transformation function (equation (2)) is as follows:

$$y^{*} = \frac{y - y_{\min}}{y_{\max} - y_{\min}}, \quad (2)$$

where y^{*} is the standardization result, y is the sample score, $y_{\max}$ is the maximum score of the sample, and $y_{\min}$ is the minimum score of the sample. After the above processing of the original sample data, the scores of the new Chinese-style clothing customer perceived evaluation index are the input data of the neural network, and the scores of the overall design of the new Chinese-style clothing are the output data of the neural network.

The raw data and normalized data of the overall design scores of samples 1–22 used for training are shown in Table 4, which is the output layer data of the neural network model.

4.2. The Selection of BP Neural Network Parameters. Feature selection is crucial to machine learning, selecting features from all features to introduce into the model that are helpful and reduce the consumption of computational resources. The main role of feature selection is to reduce the number of features to prevent dimensional disasters, reduce training time, enhance generalization, and reduce overfitting. The random forest algorithm is chosen to filter features in this paper. The random forest algorithm is one of the most widely used supervised learning algorithms to solve regression and classification problems. The random forest algorithm provides two methods of feature selection: mean

Table 4: Raw data and normalized data of the overall design score of the training sample.

No.	Original value	Normalized value
1	83.793	0.7028
2	89.487	1
3	81.026	0.5584
4	83.897	0.7083
5	85.538	0.7939
6	84.846	0.7578
7	88.027	0.9238
8	81.676	0.5923
9	86.649	0.8518
10	88.703	0.9591
11	78.703	0.4371
12	80.324	0.5218
13	72.224	0.0990
14	71.810	0.0774
15	75.431	0.2664
16	70.328	0
17	78.724	0.4382
18	79.379	0.4724
19	77.628	0.3810
20	85.070	0.7694
21	81.488	0.5825
22	87.395	0.8908

decrease impurity and mean decrease accuracy. This paper chooses the mean decrease impurity method, which can easily measure the relative importance of each feature to prediction. The higher the feature importance value, the more important the feature is to the model. After screening 32 features, the top 15 features with high feature importance values were finally selected, which are Become more popular, Exquisite structure, Exquisite design details, Promote a sense of personal confidence, Partial creative design details, Make people feel special, Good styling proportions, Exquisite decoration, Enhance personal image, Excellent manufacturing technology, Highly textured crafts such as prints and embroideries, Physiotherapy and Health Care Fabrics, Variety of matching features, A unique way of dressing, and Have an attractive story or moral. Therefore, the number of nodes in the input layer of the BP neural network is 15.

The number of hidden layer nodes is determined by trial-and-error method. When the number of hidden layer nodes is 9, the training error of the BP neural network is the smallest. The selection of the BP neural network parameters is shown in Table 5.

4.3. Particle Swam Optimization Algorithm. The selection of relevant parameters in the PSO algorithm is shown in Table 6. Figure 3 shows the change in the fitness value of the particles, that is, the MSE of the BP neural network training. The fitness value gradually decreases with the increase in the number of iterations.

4.4. Experiments. The established structure has 15 nodes in the input layer, 9 nodes in the hidden layer, and 1 node in the output layer of the three-layer BP neural network. The MATLAB model is shown in Figure 4.

Table 5: Selection of BP neural network parameters.

Parameter	Value
Number of input layer nodes	15
Number of hidden layer nodes	9
Number of output layer nodes	1
Activation function of input layer	Log-sigmoid
Activation function of hidden layer	Purelin
Learning step	0.01
The maximum number of training sessions	2000
Training error	1×10^{-3}
Error function	Mean square error (MSE)

Table 6: Selection of PSO algorithm parameters.

Parameter	Value
Number of particles	20
The maximum number of iterations	70
Individual learning factor	2
Population learning factor	2
Inertia weight	0.9
The maximum restricted velocity	3

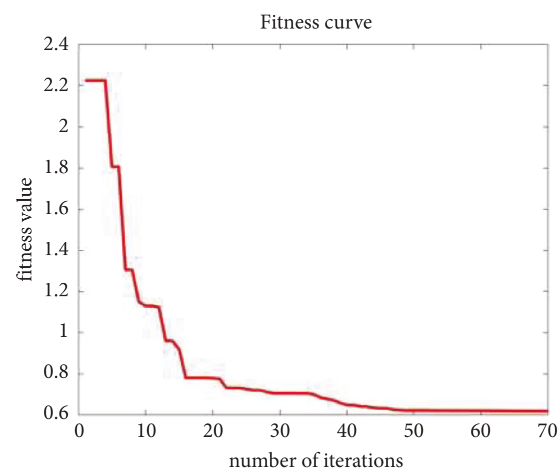

Figure 3: Plot of changes in particle swarm fitness values.

4.4.1. Training Experiment of PSO-BP Neural Network. The data of No. 1–22 new Chinese-style clothing are input into the PSO-BP neural network for training. The following “PSO-BP neural network model” will be referred to as “the model” for short. After 4 iterations, the termination conditions are met and the training is completed. As shown in Table 7, the actual value is the overall design score of No. 1–22 new Chinese-style clothing, and the predicted value is the output of the model after training with these 22 groups of data. The relative error is the relative error between the predicted value of the model and the actual value of 22 new Chinese-style clothing data. The relative error can reflect the

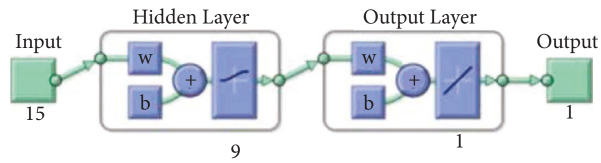

Figure 4: MATLAB model of the BP neural network.

Table 7: Training results of the PSO-BP neural network.

No.	Actual value	Predicted value	Relative error (%)
1	79.941	79.432	0.637
2	85.091	84.661	0.505
3	71.143	71.274	0.184
4	73.857	73.917	0.081
5	82.030	82.151	0.148
6	78.041	78.225	0.236
7	86.576	86.046	0.612
8	87.406	87.183	0.255
9	81.879	81.807	0.088
10	76.742	76.798	0.073
11	74.448	74.189	0.348
12	78.971	79.008	0.047
13	80.682	80.685	0.004
14	76.571	76.650	0.103
15	74.863	75.561	0.932
16	84.833	84.732	0.119
17	81.077	81.363	0.353
18	83.132	82.462	0.806
19	76.226	75.314	1.196
20	84.027	84.460	0.515
21	74.897	75.292	0.527
22	86.839	86.827	0.014

reliability of model prediction. The formula of relative error η is

$$\eta = \frac{|R - R'|}{R} \times 100\%, \tag{3}$$

where R is the actual value and R' is the predicted value of the model.

The overall design score of No. 19 new Chinese-style clothing is 76.226. The predicted value trained by the model is 75.314, and the relative error is 1.196%, which is the largest error in 22 groups of new Chinese-style clothing data. The relative error of No. 13 new Chinese-style clothing is the smallest, 0.004%. The average relative error of 22 groups of new Chinese-style clothing data is 0.354%, and the prediction results are accurate, so it can be concluded that the model has good learning ability and reliability.

4.4.2. Prediction Experiment of PSO-BP Neural Network. In order to test the prediction ability of the PSO-BP neural network model, No. 23–30 new Chinese-style clothing data were selected for testing. The following “PSO-BP neural network model” will be referred to as “the model” for short.

Table 8: Testing results of the PSO-BP neural network.

No.	Actual value	Predicted value	Relative error (%)
23	79.294	77.645	2.080
24	85.351	85.211	0.164
25	75.971	76.261	0.382
26	83.500	84.332	0.996
27	80.367	81.531	1.448
28	74.628	75.191	0.754
29	81.765	80.814	1.163
30	72.143	73.779	2.268

As shown in Table 8, the actual value is the overall design score of 8 new Chinese-style clothing from No. 22 to No. 30, and the predicted value is the predicted score of the trained model for the overall design of these 8 new Chinese-style clothing. The overall design score of No. 30 new Chinese-style clothing is 72.143, the predicted value trained by the model is 73.779, and the relative error is 2.268%, which is the largest relative error among the 8 groups of data. The average relative error of 8 groups of data is 1.157%, less than 5%, which indicates that the model is reliable and has good generalization ability. This shows that the model has certain reference significance for the evaluation of customer perceived value of new Chinese-style clothing and provides a relatively objective method for the evaluation of new Chinese-style clothing design.

4.5. Comparison between PSO-BP Neural Network Model and Traditional BP Neural Network Model. To compare the prediction accuracy of the PSO-BP neural network model and the traditional BP neural network model, the data of No. 22–30 new Chinese-style clothing were input into these two models, and the output results are compared as shown in Table 9. The following “PSO-BP neural network model” will be referred to as “the model” for short. The overall design score of No. 24 new Chinese-style clothing was 85.351, and the predicted score of the model was 85.211 with a relative error of 0.164%; the predicted score of the traditional BP neural network was 82.538 with a relative error of 3.296%. From Table 9, it is easy to find that the traditional BP neural network error fluctuates wildly, and the maximum relative error reaches 11.815%. The traditional BP neural network has the defect that it is easy to fall into the local minimum. For example, the predicted result of the customer perceived

Table 9: Comparison of traditional BP neural network and PSO-BP neural network prediction values.

No.	Actual value	PSO-BP neural network		Traditional BP neural network	
		Predicted value	Relative error (%)	Predicted value	Relative error (%)
23	79.294	77.645	2.080	79.472	0.224
24	85.351	85.211	0.164	82.538	3.296
25	75.971	76.261	0.382	78.592	3.450
26	83.500	84.332	0.996	84.084	0.699
27	80.367	81.531	1.448	82.601	2.780
28	74.628	75.191	0.754	72.849	2.384
29	81.765	80.814	1.163	81.816	0.062
30	72.143	73.779	2.268	63.619	11.815

value of No. 30 new Chinese-style clothing is quite different from the predicted result of the model. However, the relative error fluctuation of the model is small, and its error is controlled within 2.5%. The prediction accuracy of the model is obviously higher than that of traditional BP neural network, indicating that the model has better generalization ability and fault tolerance.

5. Conclusions

In the new Chinese-style clothing industry, sustainable development not only refers to the organic unity of industrial economic growth and ecological environmental protection, or the inheritance and development of traditional culture through products and modern fashion, but also includes the sustainable consumption of turning to the demand side and pursuing the harmony of supply and demand. In order to improve the evaluation level of the customer perceived value of new Chinese-style clothing and help enterprises more accurately grasp the consumer demand of products, this paper uses interview method, questionnaire survey method, exploratory factor analysis method, BP neural network, and particle swarm optimization algorithm to build new Chinese-style clothing customer perceived value measurement indicators and evaluation model, and obtains the following main conclusions.

Based on the results of open-ended questionnaire interviews, this paper summarizes 37 element factors of new Chinese-style clothing customer perceived value measurement indicators through coding procedures. Then, through exploratory factor analysis and reliability and validity analysis, the evaluation index dimensions of the customer perceived value of new Chinese-style clothing are extracted. The results show that after the dimensionality reduction of 37 element factors through factor analysis, seven dimensions can be summarized: engineering value, aesthetic value, green value, creative value, cultural and educational value, social value, and quality value.

This paper uses the ability of BP neural network to solve nonlinear problems and establishes a new Chinese-style clothing customer perceived value evaluation model based on the BP neural network. However, the BP neural network falls into local optimization and its convergence speed is slow. A new Chinese-style clothing customer perceived value evaluation model based on the particle swarm optimization algorithm is proposed. The experimental results show that the PSO-BP neural network has a very good learning and predictability in the evaluation of the customer perceived value of new Chinese-style clothing. It can evaluate the customer perceived value of new Chinese-style clothing well and provide an objective evaluation model for future new Chinese-style clothing design ideas.

The use of the new Chinese-style clothing customer perceived value measurement index allows designers to design products according to the characteristics of the target customer, avoiding the misalignment between design and demand, product homogenization, and other issues, so as to enhance the sustainable competitive advantage of enterprises. Similarly, new Chinese-style clothing enterprises can also use this measurement index to classify products, and the design plan or product can be found out in advance through the new Chinese-style clothing customer perceived value measurement index to find out its unique product personality (such as focusing on cultural and educational products, aesthetic products, green products, or creative products), which will be more conducive to market planners to carry out market classification and competitor analysis as a reference. In addition, consumers can also use this measurement index in their daily lives to improve the quality of their purchase decisions, etc. and ultimately achieve the sustainable development of the new Chinese-style clothing industry.

Data Availability

The dataset can be obtained from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

This research was supported by the National Social Science Fund of China (no. 20BG119) and Anhui Province Key Laboratory of Advanced Numerical Control and Servo Technology (no. XJSK202103), China.

Supplementary Materials

Table A. Neural network input layer data (partial). (*Supplementary Materials*)

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