Group consumers' preference recommendation algorithm model for online apparel's colour based on Kansei engineering

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ABSTRACT – REZUMAT

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The sales growth rate of men's plain-colour shirts dropped significantly online in China. Consumers first pay attention to the appearance design of clothing online. It only takes 7 seconds for consumers to determine a product, and the colour in its appearance design accounts for about 67% of the role. Thus, this study took the colour design of men's plain-colour shirts as an example in China, established the basic colour calculation scale and an algorithm model of group consumers' product preferences based on Kansei Engineering and scientific mathematics, to provide new sales ideas and methods for retailers and markets online. Firstly, this study obtained the crucial Kansei word pairs (emotional preferences) and colour design elements through interviews, literature, magazines and websites, word frequency statistics, card sorting and cluster analysis. Then, researchers established a basic colour calculation scale of cross-loading through Kansei Engineering and partial least squares (PLS). Finally, a recommendation set of products is obtained using the analytic hierarchy process (AHP), the weight of Kansei word pairs, and the distance calculation of comprehensive evaluation value based on consumers' emotional needs. That is, this study obtained consumers' aesthetic emotional preference for men's plain-colour shirts in China, colour design elements of shirts that are widely recognized and accepted, basic colour calculation scales, recommendation preferences algorithms and models for group consumers, and verified their effectiveness by PCA.

Keywords: *men's plain-colour shirts, Kansei engineering, algorithm model of recommendation, consumer's colour preference*

Modelul algoritmului de recomandare a preferințelor grupului de consumatori pentru culoarea îmbrăcămintei în mediul online, bazat pe ingineria Kansei

Rata de creștere a vânzărilor de cămăși bărbătești uni a scăzut semnificativ în mediul online din China. Consumatorii acordă mai întâi atenție aspectului estetic al îmbrăcămintei în mediul online. De fapt, consumatorii acordă doar 7 secunde pentru a alege un produs, iar culoarea reprezintă aproximativ 67%. Astfel, acest studiu a luat ca exemplu culoarea cămășilor bărbătești uni din China, a stabilit scara de calcul a culorii de bază și un model de algoritm al preferințelor de produse ale grupului de consumatori, bazat pe ingineria Kansei și matematica științifică, pentru a oferi noi idei de vânzări și metode pentru comercianții cu amănuntul și piețele online. În primul rând, acest studiu a obținut perechile de cuvinte cruciale Kansei (preferințe emoționale) și elemente de design ale culorii prin interviuri, literatură, reviste și site-uri web, statistici de frecvență a cuvintelor, sortarea cardurilor și analiza cluster. Apoi, cercetătorii au stabilit o scară de calcul a culorilor de bază pentru încărcarea încrucișată prin ingineria Kansei și analiza de regresie a celor mai mici pătrate (PLS). În cele din urmă, se obține un set de recomandări de produse utilizând procesul de ierarhie analitică (AHP), ponderea perechilor de cuvinte Kansei și calculul la distanță al valorii de evaluare cuprinzătoare pe baza nevoilor emoționale ale consumatorilor. Adică, acest studiu a obținut preferința estetică emoțională a consumatorilor pentru cămășile bărbătești uni din China, elemente de design ale culorii cămășilor care sunt recunoscute și acceptate pe scară largă, scări de calcul ale culorilor de bază, algoritmi de preferințe de recomandare și modele pentru grupul de consumatori și a verificat eficacitatea acestora prin PCA.

Cuvinte-cheie*: cămăși bărbătești uni, ingineria Kansei, model algoritmic de recomandare, preferința de culoare a consumatorului*

INTRODUCTION

Online shopping has become the leading retail channel for apparel products [1]. When the basic functional properties of clothing (protection against cold and warmth) are satisfied, more and more consumption demands are to meet consumers' aesthetic emotions and feelings. Since 2014, men's clothing, whose sales growth has exceeded that of women's clothing, has become the trend of online shopping consumption, among which men's shirts are the largest sales category [2]. However, since 2018, the sales growth rate of men's shirts on Alibaba (China's largest clothing sales platform) has declined rapidly. By 2020's Double 11, men's plain-colour shirts have become the men's clothing item with the lowest growth rate, especially in the inland regions [3]. In addition, in online sales, consumers first pay attention to the

appearance design of clothing [4]. According to the "Seven-Second Rule" of the American Fashion Colour Research Association, it only takes 7 seconds for consumers to determine their likes and dislikes for a product, and the colour in its appearance design accounts for about 67% of the role. How to quickly identify and recommend the colour design preferred by the group of consumers has become a critical factor in improving the competitiveness of men's plain-colour shirt merchants and boosting the economy of men's shirts.

Research on identifying and recommending consumer preferences can be roughly divided into two categories. The first category is for individual consumers and mainly includes rule-based, content-based and collaborative filtering recommendation systems [5, 6]. Collaborative filtering recommendation is the most widely used, speculating on the preferences of specific individual consumers by analysing the preferences of similar consumers. For example, statistics of browsing and purchase records of similar consumers [7]. However, the first category of the method is mainly used to serve individual consumers by recommending products to help them quickly online shopping. In addition, the collaborative filtering recommendation may lead to bias because similar consumers do not necessarily have the same preference, especially for experiential products such as clothing based on feeling and aesthetic emotions [8]. The second category is for group consumers to understand the overall preferences of specific groups of clothing consumers. It mainly serves merchants to increase sales and is suitable for this study. In previous research, group consumers' preferences especially involve questionnaires, big data statistics and text mining [9].

Specific to research on men's shirt group preferences, Cao [10] surveyed 1,600 men's shirt consumers in 16 cities across the country and pointed out that blue and white are the two most popular classic colours. Zhou [11] compared the preferences of group consumers in Beijing and Shanghai on men's shirts through big data. He pointed out that Beijing consumers prefer black, blue, and brown; Shanghai consumers prefer black, grey and dark green. Wu [12] processed 1.5 PB of raw data through big data computing and statistics of Hadoop clusters and pointed out that white, dark green, blue, and black are the key colours of group consumer preference for men's shirts. In contrast, text mining is an approach to obtaining group consumers' preferences from the text content. Through text mining of tens of thousands of online reviews of men's shirts, Wang and Liang [13] pointed out that white, bright colour and dark colour are the highest word frequency mentioned by group consumers. Similarly, An & Park [14] collected 38,225 texts from blogs and analysed the frequency, centrality, and semantic networks. The result is that bright colours are the group consumers' preferences in colour design. Furthermore, Wang [15] proposed an evaluation method based on text-mining word vector clustering to construct group consumer preferences. They pointed out that emotional preferences such as bright, formal, casual, and gentle are suitable for consumers' demand for the colour design of men's shirts. In these previous researches, questionnaires, big data, and text mining can only obtain consumer groups' preferences for certain shirt samples, design elements, or just emotional texts but cannot directly predict the preference ranking trends of other shirt sample sets.

Research with consumers as the main body is called "Voice of Consumers", and there are four main types of predictive research for the specific group of consumers: conjoint analysis, quality function deployment (QFD), the semantic description of environments (SMB) and Kansei Engineering [16]. Kansei Engineering (KE) is the only predictive method that can determine consumers' feelings and emotional preferences (Kansei words) and obtain the corresponding relationship between those emotional preferences and the design elements of the product specimens [17]. In addition, the analytic hierarchy process (AHP) can get the rank and weight among the multiple emotional preferences of a specific group of consumers, which is a standard data-sorting method [18]. Therefore, as shown in figure 1, this study will combine KE and the analytic hierarchy process

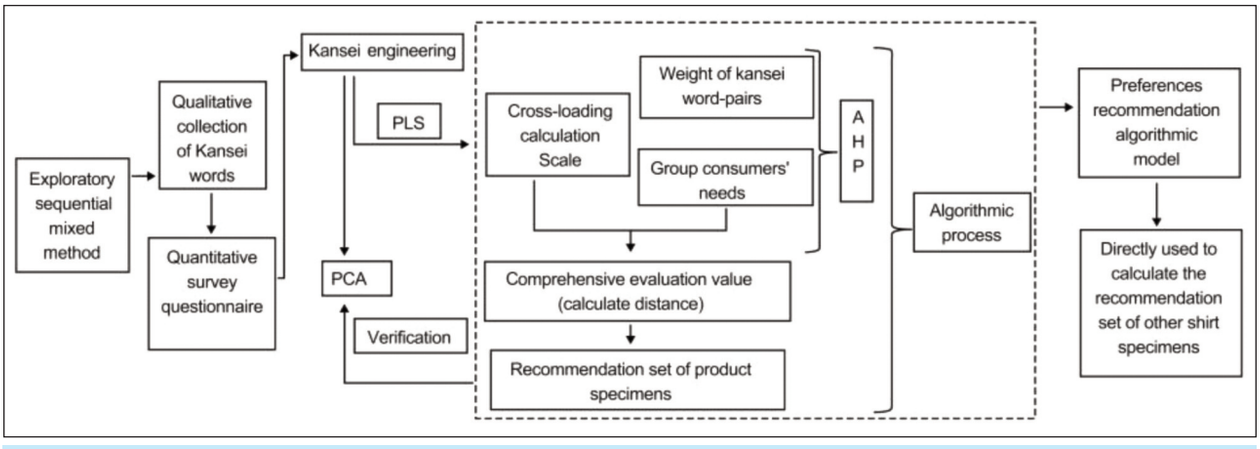

Fig. 1. Research design

(AHP), taking men's plain-colour shirts' colour design as a research object, to construct a preference recommendation algorithm model for group consumers, which can directly predict the preference ranking trends of shirt product sets, to increase sales and stimulate the economy for online clothing merchants.

EXPERIMENTAL PROCEDURE AND PREFERENCE RECOMMENDATION MODEL

Collected Kansei words and design element

This study first collected adjectives of emotional preference (Kansei words) and colour design elements consumers can identify and accept for men's plain-colour shirts. The researchers collected and selected Kansei words that appeared more than three times in word frequency statistics from consumer interviews, literature reviews, magazines, and websites with high click-through rates. Through the consumer's card sorting method and cluster analysis, the researchers can obtain the crucial Kansei word pairs that consumers were most interested in among the collected Kansei words.

In 1974, as shown in figure 2, Kobayashi discovered that the images of primary colours could be plotted on three axes: warm-cool, soft–hard, and clear–greyish. These three psychological axes of colour space are more recognized and accepted by consumers [19]. Among these, the soft-hard axis determines the value (bright/dark) parameter of colour and the clear-greyish axis determines the chroma of colours. Furthermore, as displayed in figure 3, Kobayashi [19] divided the 12 tons of colour into four types based on clear-greyish: clear, which contains V, B; clear with slightly greyish, which includes P, Vp; greyish, which contains S, Lgr, L, Gr, Dl; psychological greyish, which includes Dp, Dk, Dgr. In summary, this study will select representative colours for follow-up research based on the parameters of hue, warm-cool, soft-hard, and clear-greyish. Ou, Woodcock, and Wright [20] pointed out that the colour selected during the research should cover a wider classification space, and the span of colour parameters should be relatively large. Based on the plotted positions of colours on the warm-cool, soft–hard and clear-greyish plane (figure 2), researchers chose the colour of the classification of V, P, Dl, and Dk in figure1, which have different grayscales and large spans of warm and cold, soft and hard. Besides, researchers chose R (red), YR (yellow-red), Y (yellow), G (green), B (blue), PB (purple-blue), and P (purple) in hue, which

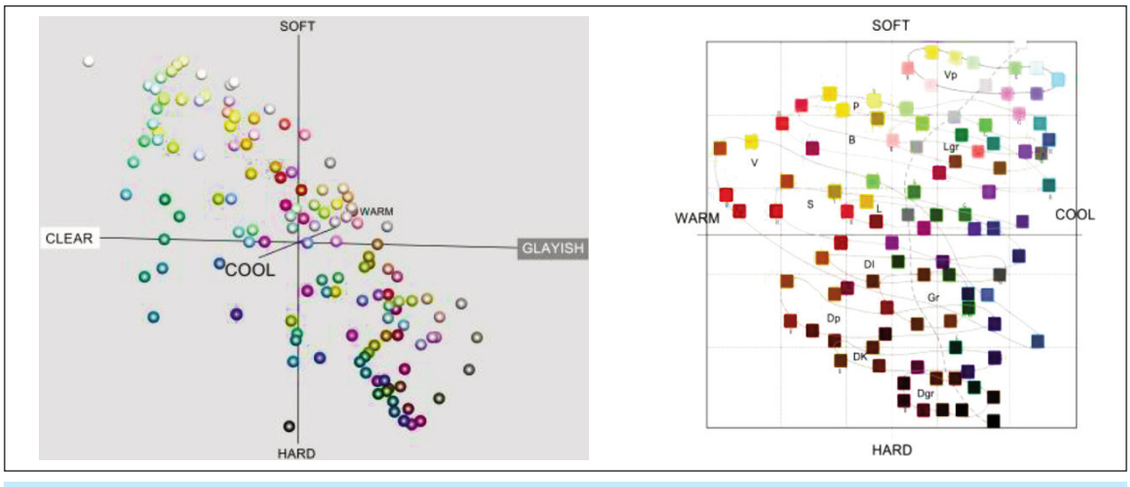

Fig. 2. Positions of colours on the warm-cool, soft–hard and clear-greyish

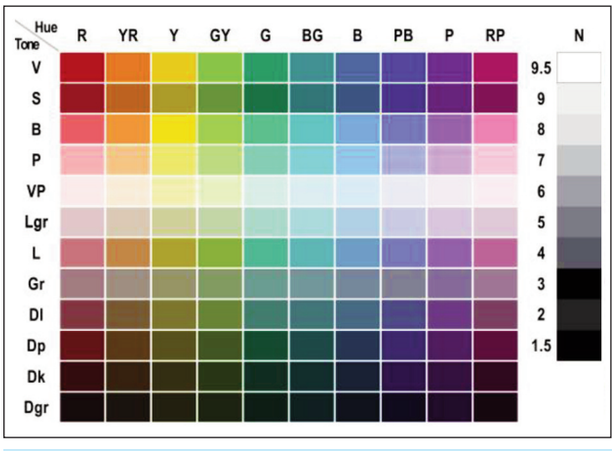

Fig. 3. 12 tons of colour

Fig. 4. 32 product specimens of colour design

has a more general acceptance for Chinese consumers. Last, researchers add the achromatic colour of black, white, and two greys. These two greys have large spans of soft and hard. Finally, a total of 32 colours were collected to conduct follow-up research, as displayed in figure 4.

Evaluation survey of a colour design questionnaire

Women consumers contributed nearly 50% of the consumption in the online menswear category. Men's clothing consumers online show a younger trend, with consumers aged 20–35 accounting for more than 80% [12]. In addition, each consumer is equally likely to be chosen in random sampling, which not be interfered with and influenced by the research team. Online questionnaires are the quickest and most effective way to collect data from lots of questions. There is no skewed data due to consumers' age and behaviour for the online questionnaires in this study because the consumers aged 20–35 are most accustomed to the Internet. Furthermore, the standard sample size is 385 for large populations based on the confidence interval approach. Therefore, focusing on consumers who have purchased men's plain-colour shirts online within one year and are aged 20–35, this study the random sampling to conduct the online questionnaire for more than 385.

In addition, Nagamachi [17] recommended the 5-level semantic differential scale questionnaire in KE, which is the most widely used. This scale of Kansei word pairs (Kansei word and denied Kansei word) has five positions, with scores of 2, 1, 0, –1, and –2, respectively. Thus, in this study, the consumers were required to select and provide the corresponding score on the Kansei word-pairs scale according to their feelings, emotions and aesthetic evaluations of the product specimens, as displayed in table 1.

Classification of product specimens

This step In KE is the design analysis of the product specimen, and it goes into a process called extraction of the design item and category. The design item refers to a certain characteristic of product design. For example, the hue, warm-cool, soft-hard, and clear-greyish are the design items. Category refers to the small groupings in each item, such as (1) red, (2) yellow-red, (3) yellow, (4) green and (5) blue for the hue item. In addition, the different categories are called design elements in colour design. As displayed in table 2, there are 18 design elements in this study. Based on that, this study classified all 32 product samples into different design items and categories for data analysis. For example, the first product specimen in figure 3 belongs to red (hue), warm (warm-cool), soft (soft-hard), and clear (clear-greyish).

Model of Partial Least Squares (PLS)

In this step, each shirt specimen in the questionnaire is decomposed into a set of design elements. For example, the design elements of the "i" shirt are represented by the set C_i, that is, $C_i = \{C_{i1}, C_{i2}, ..., C_{in}\} = \{\text{red, warm, ..., clear}\}$; the consumers' aesthetic emotional evaluation of the "i" shirt is represented by the set F_i, $F_i = \{F_{i1}, F_{i2}, ..., F_{in}\}$. Using the model of partial least squares (PLS) ($C \xrightarrow{f} F$), for any C_i, F_i can be calculated.

Analytic hierarchy process

The analytic Hierarchy Process (AHP) in this study is a quantification method for consumers' aesthetic emotional needs and importance. Its principle is to

Table 1

5-LEVEL SEMANTIC DIFFERENTIAL SCALE QUESTIONNAIRE								
Product specimen		**KW**	**2**	**1**	**0**	**–1**	**–2**	**KW**
	1	Practical	○	○	○	○	○	Unpractical
	2	Mature	○	○	○	○	○	Childish
	3	Distinctive	○	○	○	○	○	General
	4	Elegant	○	○	○	○	○	Inelegant
	5	Minimalist	○	○	○	○	○	Garishas
	6	Formal	○	○	○	○	○	Casual

Table 2

ITEM/CATEGORY CLASSIFICATION LIST OF COLOUR	
Item	**Category**
Hue	(C1) Red, (C2) yellow-red, (C3) yellow, (C4) green, (C5) blue, (C6) purple-blue, (C7) purple, (C8) black, (C9) white, (C10) grey
Warm-cool	(C11) Warm, (C12) cool
Soft-hard	(C13) Soft, (C14) hard
Clear-greyish	(C15) Clear, (C16) Clear with slightly greyish, (C17) Greyish, (C18) psychological greyish

compare the emotional preference (Kanword pair-sairs) in turn according to a certain rule to generate a judgment matrix:

$$A = (a_{ij})_{n\times n} = \begin{pmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{pmatrix}, \quad (1)$$

$$(i,j = 1,2,...,n)$$

According to the judgment matrix A, by calculating the eigenvalues and eigenvectors, the researchers obtained the relative weights of the compared Kansei word pairs to the corresponding criteria in the upper level are obtained, which is $W = (\omega_1, \omega_2, ..., \omega_n)^T$.

$$AW = \lambda_{max} W \Rightarrow w_k = \frac{\sum_{j=1}^{n} a_{kj}}{\sum_{i=1}^{n}\sum_{j=1}^{n} a_{kj}} \quad (2)$$

The researchers conducted the CR test of the consistency ratio of the judgment matrix, calculated the total ranking weight of each Kansei word-pairs for the system, and sorted it.

$$CR = \frac{CI}{RI} = \frac{\lambda_{max}(A) - n}{(n-1)RI_n} \quad (3)$$

When $CR < 0.1$, it is judged that the pairwise comparison matrix A has satisfactory consistency.

Comprehensive evaluation value

This step is the most critical in the whole preferences recommendation algorithm model. After the researchers obtain the aesthetic emotional needs of consumers as $F_0 = \{F_{01}, F_{02}, ..., F_{0n}\}$, according to the result of partial least square (cross-loading calculation scale) in step 4 and the weight of Kansei word-pairs in step 5, the comprehensive evaluation value D of each men's shirt can be obtained.

$$D = \sqrt{W_0 \circ ((F_{i1} - F_{01})^2, (F_{i2} - F_{02})^2, ..., (F_{im} - F_{0m})^2)^T} \quad (4)$$

Researchers can rank specimens according to the comprehensive evaluation value. The D value represents the distance between the specimens and the aesthetic and emotional needs of the group of consumers, which means the smaller the D value, the closer the specimen is to the emotional need of the group of consumers. Based on this, a set of recommended shirts can be formed.

EXPERIMENTAL RESULTS AND DISCUSSION

Collected Kansei words

In this study, researchers interviewed 20 consumers and examined eight literature reviews, 47 electronic magazines and high-clicked websites to collect Kansei words concerning men's plain-colour shirts. Through word frequency statistics, the consumers' card sorting and corresponding cluster analysis, the crucial aesthetic emotional preferences (Kansei words-pairs) that consumers are most interested in the inland region of China are obtained. That is, practical—unpractical, mature—childish, distinctive—general, elegant—inelegant, minimalist—garishas, formal—casual.

Cross-loading calculation scale

A professional questionnaire website was responsible for inviting respondents to answer the questionnaires. A total of 549 questionnaire samples remained after screening. The Cronbach's alpha for this questionnaire is 0.871 (> 0.75), and the Kaiser-Meyer-Olkin (KMO) is 0.813 (> 0.75), indicating the reliability and validity of the samples in this study are accepted. Hence, the PLS can be further carried out. Partial least squares (PLS) can decompose the components, which reduces the dimension of the features, reconstructs the model, and obtains a simple linear regression model (Chin et al., 2013). This study uses SAS_9.4 as the data analysis tool and through PLS to construct the corresponding relationship between men's shirt colour design elements and consumers' emotional preferences (Kansei word pairs), as shown in table 3. According to the analysis result, one specific emotional preference F_i = {regression constant + $c1$* regression coefficient… + $c18$* regression coefficient}. This cross-loading scale can be used for the calculation basis of the group consumers' preference recommendation algorithm model for men's plain-colour shirts in the inland region of China, based on which other men's plain-colour shirt colour specimens can be calculated and recommended directly.

Weight of Kansei word-pairs

As shown in table 4, through the analysis of some parts of the questionnaire data, this study obtained the degree of attention of some groups of consumers to shirt aesthetic emotional preference to facilitate the description of the follow-up model method. Based on this, researchers rounded and unified the weight evaluation of the importance of Kansei word pairs by using the AHP method and obtained the weight W = {0.0712, 0.0712, 0.0345, 0.3330, 0.3330, 0.1571}, where random CR = 0.028 < 0.1, which can be determined that the consistency of the pairwise comparison matrix A is acceptable.

Recommendation ranking

As shown in table 5, this study obtained these some group consumers' aesthetic emotional needs as F_0 = {1,1,1,1,1,1}, according to the questionnaire analysis. The distance of each product specimen is calculated by comprehensive evaluation value D (as mentioned in Step 6 before). Thus, group consumers' preference and recommendation ranking for about 32 samples is obtained based on the principle of recommending shirt specimens with small distances. The calculation shows that this study's recommendation algorithm model recommends 31/30/20/17/18/19/22/26/2/32/14 as the product specimens set of consumer preference. In addition, the set of product

Table 3

CROSS-LOADING CALCULATION SCALE						
Elements	**Practical—Unpractical**	**Mature—Childish**	**Distinctive—General**	**Elegant—Inelegant**	**Minimalist—Garishas**	**Formal—Casual**
Intercept	–0.059	0.494	0.379	0.194	0.570	-0.319
c1	0.011	0.148	–0.021	0.371	0.399	0.184
c2	0.171	–0.264	–0.148	–0.356	–0.312	-0.447
c3	–0.042	–0.054	0.315	–0.446	–0.450	-0.274
c4	–0.370	–0.318	0.050	–0.204	–0.206	-0.268
c5	0.251	0.312	–0.444	0.446	0.453	0.468
c6	–0.083	–0.141	0.098	–0.047	–0.043	–0.013
c7	–0.224	–0.260	0.298	–0.121	–0.105	–0.091
c8	0.291	0.493	0.297	0.054	0.094	0.205
c9	0.518	0.600	–0.482	0.647	0.509	0.576
c10	0.114	0.514	–0.181	0.304	0.182	0.418
c11	0.005	–0.111	0.119	–0.215	–0.170	–0.260
c12	–0.005	0.111	–0.119	0.215	0.170	0.260
c13	–0.038	–0.260	0.014	0.335	0.116	–0.018
c14	0.038	0.260	–0.014	–0.335	–0.116	0.018
c15	–0.380	–0.154	0.271	–0.022	–0.023	–0.205
c16	0.215	–0.326	–0.139	0.345	0.131	0.074
c17	0.152	0.185	0.158	–0.131	–0.042	–0.372
c18	0.055	0.290	–0.369	–0.164	–0.054	0.609

Table 4

GROUP CONSUMERS' ATTENTION DEGREE TO KANSEI WORD-PAIRS					
Code	**KW**	**Medium**	**More**	**Fairly**	**Quite**
k1	Practical—Unpractical		✓		
k2	Mature—Childish		✓		
k3	Distinctive—General	✓			
k4	Elegant—Inelegant				✓
k5	Minimalist—Garishas				✓
k6	Formal—Casual			✓	

Table 5

GROUP CONSUMERS' AESTHETIC AND EMOTIONAL NEEDS						
Code	**KW**	**Medium**	**More**	**Fairly**	**Quite**	**KW**
1	Practical		✓			Unpractical
2	Mature		✓			Childish
3	Distinctive		✓			General
4	Elegant		✓			Inelegant
5	Minimalist		✓			Garishas
6	Formal		✓			Casual

specimens that the recommendation algorithm model least recommends is 11/7/12/8/25/9/5/15.

EXPERIMENTAL VERIFICATION

Principal Component Analysis

Principal Component Analysis (PCA) in Kansei Engineering is used to compress data into fewer dimensions, visually analysing the distribution of Kansei word pairs to determine and verify consumers' emotional preferences. It also can assess consumer preferences degree for product specimens based on their relative positions on the X/Y axis. This study uses PCA to verify consumer emotional preferences and rank the shirt specimens. As shown in figure 5,

PCA's cumulative contribution to consumers' emotional evaluation of colour design is 77.8%, indicating that Kansei word pairs have significant weights. Kansei word pairs are distributed in the first, second and fourth quadrants of PCA. Since there is no distribution of Kansei word pairs in the third quadrant, PCA verifies that these six Kansei word pairs are all consumer preferences. The x-axis contributes 51.3%, while the y-axis contributes 26.5%. According to the contribution ratio of the x/y axis and the relative positions of the 32 product specimens, the order of importance of each product specimen to consumers is assessed in PCA, as displayed in figure 6.

PCA recommends 31/30/20/17/18/22/26/19/14/2/32 as the product specimens set of consumer preference. In addition, the set of product specimens that the PCA least recommends is 11/7/12/8/9/25/5/15. Although the recommended specimens order between PCA and the recommendation algorithm model of this study is slightly different, the recommendation trend for product specimens and the results of recommended product specimens set are consistent, thus verifying the validity of the recommendation preferences algorithm model in this study.

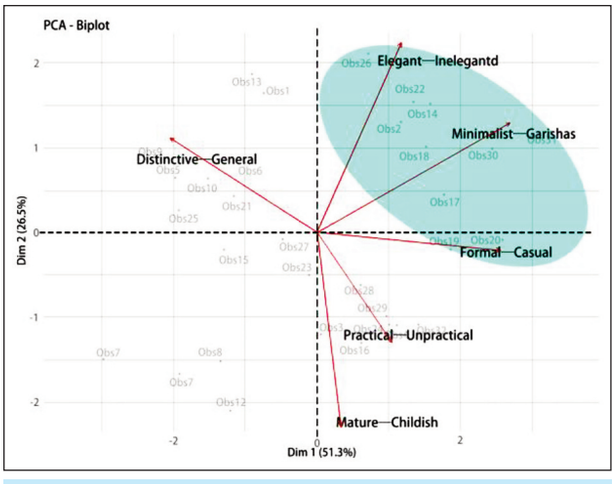

Fig. 5. PCA of men's plain-colour shirts

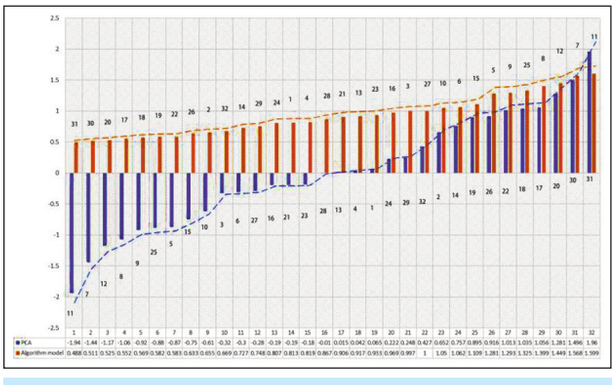

Fig. 6. Comparison between PCA and recommendation algorithm model

Case study

The Shan Dong area was selected as a specific case study to validate the proposed recommendation algorithm in this study. Researchers investigate the consumers of 20–35-year-olds and obtain group consumers' attention degree to Kansei word pairs and aesthetic emotional needs. Based on this, researchers rounded and unified the weight evaluation of the importance of Kansei word pairs by using the AHP method and obtained the weight $W = \{0.1175, 0.1175, 0.0316, 0.3080, 0.3080, 0.1175\}$, where random $CR = 0.020 < 0.1$. As 10 product specimens as research objects (figure 7), the order of product samples obtained according to this study's preference recommendation algorithm model is 9/6/5/2/7/3/1/8/10/4. At the same time, this study conducted a preference questionnaires survey of the same 10 samples among 437 consumers aged 20–35 and obtained the product sample preference order as follows: 9/5/6/7/2/3/1/4/8/10. It can be seen that the ranking trend of the product set calculated by the recommendation algorithm model is consistent with the consumer preference trend.

CONCLUSION

Innovation

As mentioned in the introduction, questionnaire surveys and big data are only summary statistics of consumer preference for specific product samples or particular colour design elements and features. If new product samples or design element appears, a large-scale survey and statistics must be carried out again. Text mining can count the emotional words (Kansei words) and specific design elements or features of group consumers' preference for colour design, but it cannot establish the relationship between these emotional words and design elements or features. Thus, they cannot calculate and score the consumer's preference for specific shirt product sets, and of course, they all cannot directly predict the preference ranking trends of other shirt product sets. Kansei Engineering can predictably establish the relationship between the emotional words and design elements or features, and form the cross-loading scale of clothing. On this basis, the preference ranking trend of clothing products is obtained

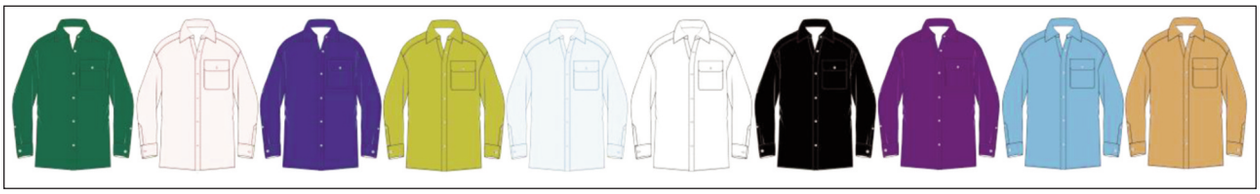

Fig. 7. 10 product specimens of the case study

through the weight analysis of AHP of emotional words and the distance calculation. That is, after getting the cross-loading scale of KE and the weight of the emotional words of consumers in a specific region, the preference score of any similar products and the ranking trend of the product set can be predictively calculated. Therefore, the combined recommendation algorithm model of KE and AHP to calculate the preference ranking trend of clothing products is the most significant innovation of this research. It is more predictive and efficient than traditional questionnaires, big data and text mining.

Main contributions

First, this study obtained the Kansei words of consumer groups' aesthetic and emotional preferences for men's plain-colour shirts in the inland region of China. That is, practical, mature, distinctive, elegant, minimalist, formal and casual. Second, this study obtained 18 colour design elements of shirts that are widely recognized and accepted. Third, the cross-loading scale between shirts' colour design elements and the emotional preferences of consumers was obtained through KE. That is the relationship between the consumers' preferred emotional words (Kansei words) and colour design elements. It can be directly used as a basic calculation scale to recommend men's plain-colour shirts to provide references for the online shirt designer and market. Last and most importantly, this study establishes the recommendation algorithm model for the preferences of the group consumers based on the cross-loading scale and AHP, which can directly calculate the sorting trend of men's plain-colour shirt products, and generate a set of recommended products to improve the sales of men's shirts for online merchants.

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