Perceptual evaluation of female trench coat design based on Quantitative Theory I

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ABSTRACT – REZUMAT

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In the process of apparel design, understanding consumers' emotional demand is crucial to creating satisfactory garment styles. To solve the problem of the mismatch between consumers' personalised needs and the design of trench coat styles. This paper focuses on women's trench coats and proposes a style design research method that combines Quantification Theory I and Kansei Engineering. Initially, it employs the Semantic Difference Analysis Method to extract consumers' emotional evaluations of trench coat samples. Using SPSS software, it analyses the emotional ratings and identifies key emotional factors, constructing a two-dimensional emotional distribution map for trench coat styles. Simultaneously, it analyses style characteristics to extract the main design elements. Building on this, it integrates Quantification Theory I and performs linear regression, predicting relationships between emotional factors and design elements and establishing a mathematical model. This model exhibits a high degree of fit between measured and predicted values and adheres to normal distribution requirements, demonstrating its effectiveness. Ultimately, the study validates the mathematical model through real consumer design cases, further confirming that it can effectively translate consumers' emotional needs into trench coat design elements, thus providing significant insights and references for women's trench coat style design.

Keywords: *Quantitative Theory I, trench coat, Kansei Engineering, design element, factor, perceptual words*

Evaluarea perceptivă a designului trenciului de damă pe baza Teoriei cuantificării I

În procesul de proiectare a articolelor vestimentare, înțelegerea cererii emoționale a consumatorilor este esențială pentru crearea unor stiluri vestimentare satisfăcătoare. Pentru a rezolva problema nepotrivirii dintre nevoile personalizate ale consumatorilor și designul stilurilor de trenciuri, această lucrare se concentrează pe trenciurile de damă și propune o metodă de cercetare a designului stilistic care combină Teoria cuantificării I și ingineria Kansei. Inițial, utilizează metoda analizei diferențelor semantice pentru a extrage evaluările emoționale ale consumatorilor cu privire la mostrele de trenciuri. Folosind software-ul SPSS, analizează evaluările emoționale și identifică factorii emoționali cheie, construind o hartă bidimensională a distribuției emoționale pentru stilurile de trenciuri. Simultan, analizează caracteristicile stilului pentru a extrage principalele elemente de design. Pe baza acestui lucru, integrează Teoria cuantificării I și efectuează o analiză de regresie liniară, care prezice relațiile dintre factorii emoționali și elementele de design, stabilind un model matematic. Acest model prezintă un grad ridicat de potrivire între valorile măsurate și cele prevăzute și respectă cerințele de distribuție normală, demonstrând eficacitatea sa. În cele din urmă, studiul validează modelul matematic prin cazuri reale de design ale consumatorilor, confirmând în continuare că poate traduce în mod eficient nevoile emoționale ale consumatorilor în elemente de design ale trenciurilor, oferind astfel informații și referințe semnificative pentru designul stilului trenciurilor de damă.

Cuvinte-cheie*: Teoria cuantificării I, trenci, inginerie Kansei, element de design, factor, cuvinte perceptuale*

INTRODUCTION

In response to the ever-changing dressing requirements and fashion preferences of consumers, the application of Kansei Engineering in clothing design has gained notable attention [1–3].

Kansei Engineering [4], a theory exploring the relationship between human emotions, sensations, experiences, and product design, primarily aims to systematically capture and analyse consumers' emotional needs [5]. It transforms these needs into concrete design elements to organically integrate design with consumer demands [6]. In clothing design, the application of Kansei Engineering broadly covers various styles, including suits [7, 8], winter coats [9], sports lingerie and qipaos [10, 11], as well as multiple aspects like fabric, colour, patterns, and sizes [12–16]. However, despite its significant advantages, Kansei Engineering in clothing design faces limitations. This arises mainly because its research data relies predominantly on users' subjective evaluations [17–19], which can lack a degree of objectivity [20].

To overcome this limitation, this study introduces Quantitative Theory I. Through the application of mathematical models and statistical analysis tools, it constructs complex multidimensional models. This

approach captures the intricate relationship between design elements and emotional needs more accurately [21, 22]. By effectively transforming consumer emotional needs into stylistic design factors, the theory reflects consumer expectations more realistically and promptly responds to market changes, providing strong support for adjustments in design and marketing strategies [23]. Some scholars have already combined affective engineering with Quantitative Theory I in the realms of patterns [24] and product design [22]. However, only a few scholars have applied it to research on clothing style design [23, 25].

Based on the current research status, this study focuses on the women's trench coat. Integrating affective engineering and Quantitative Theory I. First, it employs affective engineering to evaluate the emotional attributes of trench coat styles and constructs a two-dimensional quadrant distribution map of trench coat samples via factor analysis. Next, grounded in this foundation, it derives a mathematical predictive model for women's trench coat style design by incorporating Quantitative Theory I. Finally, it validates the reliability of this model through actual case studies, intending to provide valuable references for designers and enhance the market competitiveness of trench coat styles.

KANSEI ENGINEERING ANALYSIS

Collection sample and design element

A total of 189 images of women's trench coats were initially collected from Amazon's official website and the POP fashion trend forecasting platform. To ensure the accuracy and relevance of the data, five experts specialising in trench coat design and fashion trend analysis were invited to assist in the selection and refinement of the dataset. Each expert possesses over a decade of experience in apparel design or fashion research, providing valuable insights into the curation process. Following a rigorous evaluation, 30 representative trench coat styles were identified as the final study samples. In order to avoid differences in fabrics, materials, colours and patterns that may cause bias in the evaluation results of the questionnaire, the trench coat samples were transformed into pure black and white line drawings [26–27] and randomly arranged in one number, as shown in figure 1.

Trench coat style is mainly composed of external contours and internal details, through the research of clothing style literature and discussions with professional designers of trench coat, according to the morphological disassembling method to break down the trench coat style into different components and the

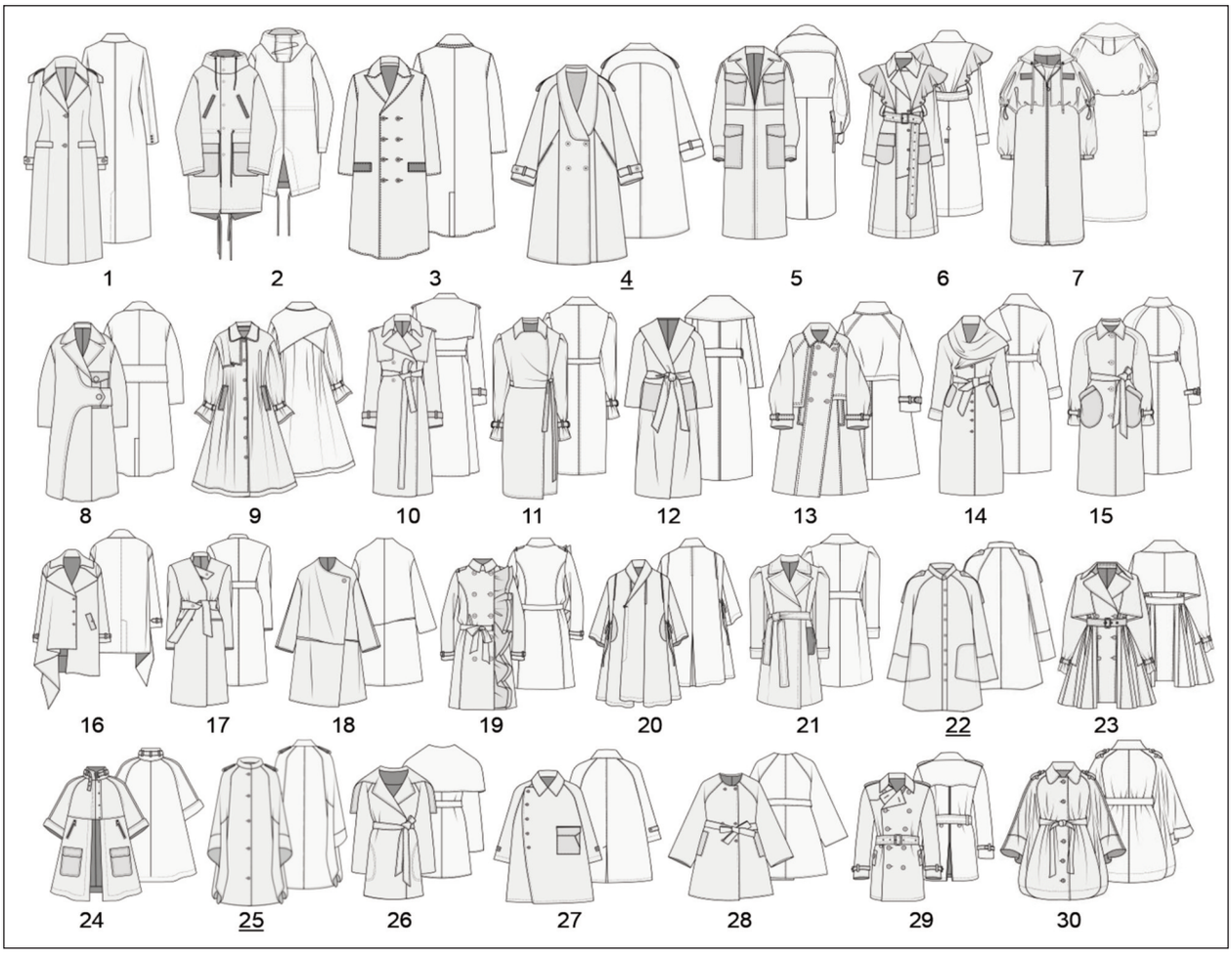

Fig. 1. Samples of women's trench coats

Table 1

DESIGN ELEMENTS OF A WOMAN'S TRENCH COAT

Design elements	Sub-elements	Design elements	Sub-elements	Design elements	Sub-elements
silhouette (A)	H A_1		collarless C_9	length (G)	regular length G_1
	X A_2	sleeve (D)	straight sleeve D_1		medium length G_2
	A A_3		dropped shoulder D_2		long length G_3
size (B)	close-fitting B_1		darted head D_3	pocket (H)	flap pocket H_1
	easy fitting B_2		kimono sleeves D_4		patch pocket H_2
collar (C)	collar and rever with complete stand C_1		raglan sleeve D_5		insert pocket H_3
	classic gents collar C_2		flared raglan D_6		pocketless H_4
	classic reefer collar C_3	fastening method (E)	button E_1		multiple pocket combinations H_5
	shawl collar C_4		belt E_2	construction lines (I)	seams I_1
	stand collar C_5		zipper E_3		dart I_2
	hooded collar C_6	flap (F)	straight F_1		dart less I_3
	asymmetric collar C_7		slant F_2	yoke (J)	yoke J_1
	roll collar C_8		asymmetric F_3		yokeless J_2

corresponding modeling elements, and screen the decomposition of the elements, and ultimately determine the most representative of the trench coat design of the 10 main elements and 39 sub-elements, as shown in table 1.

Perceptual questionnaire design

By consulting relevant professional literature, apparel websites, and consumer reviews, eight perceptual words were identified as measurement scales. A 5-level semantic differential scale questionnaire was designed based on semantic differentiation. This scale was applied to assess the trench coat styles against the eight pairs of perceptual words, as shown in figure 2.

ANALYSIS OF RESEARCH FINDINGS

Validity and correlation analyses

Employed SPSS 26.0 software to conduct KMO and Bartlett's test of spherical on the average evaluation scores of perceptual words. The results indicated a KMO value of 0.712 (>0.7) and a Bartlett's test of sphericity with 28 degrees of freedom, yielding a significance P-value of 0.000 (<0.05). This demonstrates that the data analysis results are robust and that the original variables are appropriate for subsequent factor analysis [30]. Through Pearson correlation analysis, a correlation analysis matrix for perceptual words related to trench coats was obtained. In this matrix, higher absolute values of subjective scores indicate stronger correlations [30], for example, if the two perceptual terms "steady-vivid" and "mature-youthful" have the highest ratings in "vocational-casual", they show a high correlation with each other, indicating that trench coat styles with a sense of vocational bring an objective impression of steady and mature, while casual styles usually bring a young and energetic impression, as shown in table 2.

Factor analysis

Using principal component analysis to derive the total variance of the explanation of 8 pairs of perceptual words, 2 principal component factors were extracted, and the cumulative contribution rate reached 79.1%,

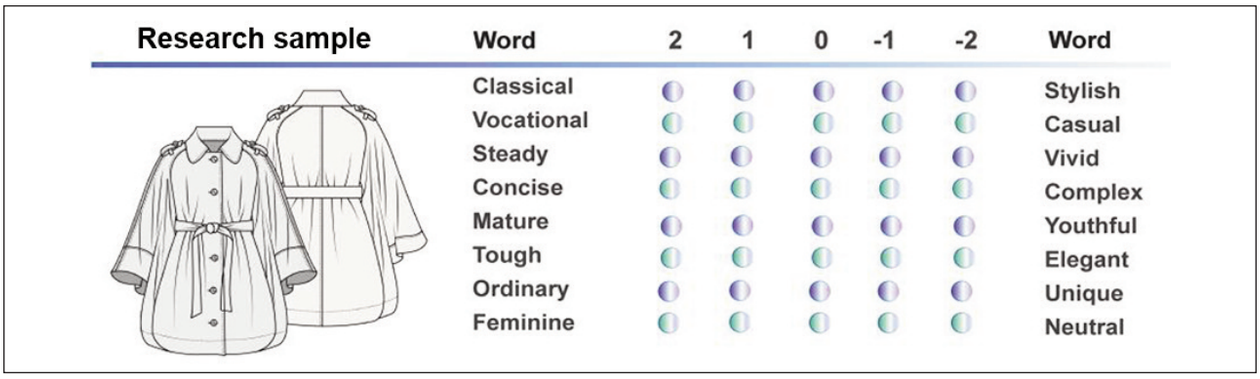

Fig. 2. 5-level semantic differential scale questionnaire

Table 2

CORRELATION ANALYSIS MATRIX								
Vocabulary	**Classical-stylish**	**Vocational-casual**	**Steady-vivid**	**Concise-complex**	**Mature-youthful**	**Tough-elegant**	**Ordinary-unique**	**Feminine-neutral**
Classical-stylish	1.000	0.561	0.762	0.580	0.666	0.457	0.910	–0.345
Vocational-casual	-	1.000	0.670	0.462	0.578	0.333	0.538	0.094
Steady-vivid	-	-	1.000	0.778	0.918	0.359	0.737	–0.180
Concise-complex	-	-	-	1.000	0.743	0.356	0.613	–0.201
Mature-youthful	-	-	-	-	1.000	0.157	0.675	–0.059
Tough-elegant	-	-	-	-	-	1.000	0.394	–0.774
Ordinary-unique	-	-	-	-	-	-	1.000	–0.228
Feminine-neutral	-	-	-	-	-	-	-	1.000

indicating that the majority of the original factor's eigenvalue information remains preserved [31]. This better reflects the meanings of the original adjectives, thereby effectively portraying the participants' emotional evaluations of samples, as shown in table 3.

Using the maximum variance method for orthogonal rotation, we derived the factor loading matrix after rotation, as shown in table 4. The perceptual words for Factor 1 include: "steady-vivid, mature-youthful, ordinary-unique, classical-stylish, concise-complex, and vocational-casual". The results indicate that these six pairs of perceptual words exhibit high loading on Factor 1 M_1, suggesting that a significant amount of variable information resides in the first principal component. Based on the meaning expressed by this factor, we named the first factor the Charm Factor M_1. In contrast, the pairs "feminine-neutral and tough-elegant" have high loading on Factor 2, which we named the second factor as the Personality Factor M_2.

Using multivariate regression analysis, we derived the factor score coefficients for two factors and established a factor score coefficient matrix for each factor [23]. This allows us to assess the linear relationship between each variable and the factors, thereby explaining the results of the factor analysis and

Table 3

THE PERCEPTUAL WORDS EXPLAIN THE TOTAL VARIANCE						
Vocabulary	**Initial eigenvalues**			**Extraction Sums of Squared Loading**		
	Total	**%of Variance**	**Cumulative%**	**Total**	**%of Variance**	**Cumulative%**
Classical-stylish	4.711	58.886	58.886	4.711	58.886	58.886
Vocational-casual	1.617	20.215	79.100	1.617	20.215	79.100
Steady-vivid	0.636	7.948	87.048	-	-	-
Concise-complex	0.545	6.812	93.860	-	-	-
Mature-youthful	0.274	3.425	97.286	-	-	-
Tough-elegant	0.100	1.247	98.532	-	-	-
Ordinary-unique	0.065	0.817	99.349	-	-	-
Feminine-neutral	0.052	0.651	100.000	-	-	-

Table 4

SPECIFIC FACTOR SCORE LOADING MATRIX						
LOAD MATRIX AFTER ROTATION				**FACTOR SCORE COEFFICIENT MATRIX**		
Factor name	**Perceptual words**	**M_1**	**M_2**	**Perceptual words**	**M_1**	**M_2**
Charm factor M_1	Steady-vivid	0.940	0.144	Classical-stylish	0.165	0.102
	Mature-youthful	0.919	–0.026	Vocational-casual	0.201	–0.114
	Ordinary-unique	0.830	0.273	Steady-vivid	0.225	–0.040
	Classical-stylish	0.818	0.366	Concise-complex	0.181	0.003
	Concise-complex	0.792	0.187	Mature-youthful	0.242	–0.135
	Vocational-casual	0.759	–0.027	Tough-elegant	–0.052	0.477
Personality factor M_2	Feminine-neutral	–0.007	–0.957	Ordinary-unique	0.180	0.048
	Tough-elegant	0.249	0.893	Feminine-neutral	0.123	–0.546

facilitating subsequent analysis and inference. The specific factor score loading matrix is shown in table 4.

Quadrant analysis

Based on the factor score coefficient matrix, we derive the calculation formulas for samples. The calculation method for M_1 is as shown in equation 1. The calculation method for M_2 is in equation 2. In these formulas, X_1 to X_8 represent the average semantic score of each woman's trench coat sample on the perceptual words, respectively.

$$F_1 = 0.165X_1 + 0.201X_2 + 0.225X_3 + 0.181X_4 + \\ + 0.242X_5 - 0.052X_6 + 0.180X_7 + 0.123X_8 \quad (1)$$

$$F_2 = 0.102X_1 - 0.114X_2 - 0.040X_3 + 0.003X_4 - \\ - 0.135X_5 + 0.477X_6 + 0.048X_7 - 0.546X_8 \quad (2)$$

In order to visualise the sample design characteristics, using the scores of Factor 1 as the horizontal coordinates and the scores of Factor 2 as the vertical coordinates, create a two-dimensional phase limit distribution diagram, as shown in figure 3.

As shown in figure 4, it is evident that styles in the first quadrant exemplify elegance and style. Their silhouettes primarily feature A and H shapes, with embellishments like ruffles and ties. The hemlines tend to showcase flowing, loose pleated designs that add a lively touch to the overall elegance. Style in the second quadrant is simple and ordinary, with a predominantly A-shaped silhouette, giving the impression of maturity and stability. In the third quadrant, trench coat styles present a more classic design, featuring straight H-shaped lines that convey a disciplined and professional image. Lastly, in the fourth quadrant, embody an avant-garde and casual aesthetic. Their silhouettes prioritise comfort and looseness, showcasing an overall youthful and lively style that incorporates unique asymmetric decorative segments and connections. This adds a tough feel to the design, ensuring that the garments remain both stylish and practical.

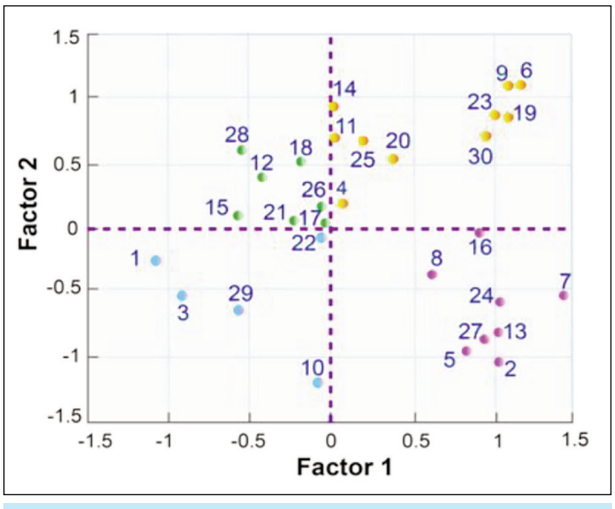

Fig. 3. Two-dimensional phase limit distribution diagram

CONSTRUCTION OF QUANTIFICATION THEORY I MODEL

Construction of a trench coat predictive model

Based on Quantitative Theory I, the study set the trench coat design elements as "items", the design sub-elements as "categories", and the perceptual word scores of samples as the baseline variable (y). Suppose there are m items, and the category of the i^{th} item is D_i, then for n samples, $y(n) = r_{ij}(n)$ is called the reaction of item i, category j in sample n, which can be obtained.

$$r_{ij} = \begin{cases} 1, \text{ (the } n^{th} \text{ sample, the qualitative date of} \\ \quad \text{item } i \text{ is category } j) \\ 0, \text{ (others)} \end{cases} \quad (3)$$

It is assumed that there is a linear relationship between the dependent variable and the response of each item and category object, then a mathematical model can be established [13]:

$$y(n) = \sum_{i=1}^{m} \sum_{j=1}^{D_i} r_{ij}(n)\, a_{ij} + \varepsilon_n \quad (4)$$

In the formula: $r_{ij}(n)$ only depends on the coefficient of category j of item i; a_{ij} is a quantitative representation of the fixed variable $r_{ij}(n)$; ε_n random error in the n^{th} sampling, and r_i denotes the number of classes in the i^{th} item [2].

Based on formula 3 and the sample shown in figure 1, this study matched design elements for 30 trench coats. If a sample possesses this item, it receives a value of 1; otherwise, it receives a value of 0. This established the corresponding trench coat reaction matrix, as shown in table 5.

With the ration matrix as independent variables and the evaluation value of perceptual words as dependent variables. Further utilise SPSS 26.0 to apply multivariate linear regression analysis on the developed mathematical model for an approximate solution. After eliminating ineffective variables, obtain specific results from the linear regression analysis, as shown in table 6. The item's partial correlation coefficient represents the correlation between various design elements and image adjectives. The sub-element scores indicate the association levels between the sub-elements of design elements and corresponding perceptual words, with positive and negative values indicating the direction of the associations.

In table 6, the partial correlation coefficient represents the degree of influence of design elements on the emotional factors. The category sub-element indicates the degree of influence of the subcategory of design elements on emotional factors, with the sign of the value indicating the direction of the influence. According to the constant terms and sub-element scores of each group's perceptual word, the multiple linear regression equation of the charm factor and personality factor can be obtained.

Table 5

REACTION MATRIX																		
Sample number	**A_1**	**A_2**	**A_3**	**B_1**	**B_2**	**C_1**	**C_2**	**C_3**	…	**H_2**	**H_3**	**H_4**	**H_5**	**I_1**	**I_2**	**I_3**	**J_1**	**J_2**
1	0	1	0	1	0	0	1	0	…	0	0	0	0	0	1	0	0	1
2	1	0	0	0	1	0	0	0	…	0	0	0	1	0	0	1	0	1
3	1	0	0	0	1	0	0	1	…	0	0	0	0	0	0	1	0	1
4	0	0	1	0	1	0	0	0	…	0	1	0	0	1	0	0	0	1
5	1	0	0	0	1	0	1	0	…	1	0	0	0	1	0	0	0	1
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
26	1	0	0	0	1	0	0	0	…	0	1	0	0	0	0	1	0	1
27	0	0	1	0	1	0	0	0	…	1	0	0	0	1	0	0	0	1
28	0	0	1	0	1	0	0	0	…	0	1	0	0	0	0	1	0	1
29	1	0	0	0	0	1	0	0	…	0	1	0	0	0	0	1	1	0
30	0	0	1	0	0	0	0	0	…	0	0	1	0	0	0	1	0	1

Table 6

ANALYSIS OF THE LINEAR RELATIONSHIP TO FACTOR 1							
Design elements	**Sub element**	**Sub-element score**	**Partial correlation coefficient**	**Design elements**	**Sub element**	**Sub-element score**	**Partial correlation coefficient**
A	A_1	–1.570	–0.471	D	D_5	–0.310	–0.216
	A_2	0.029			D_6	–0.017	
B	B_1	0.526	–0.097	E	E_3	0.653	0.338
	B_2	0.551			E_4	1.039	
C	C_2	0.231	–0.154	F	F_2	–0.375	0.351
	C_3	0.543			F_3	0.533	
	C_4	–0.144		G	G_1	0.101	–0.433
	C_5	–0.285			G_3	–0.085	
	C_6	1.068		H	H_1	–1.244	0.264
	C_7	–0.545			H_2	–0.146	
	C_8	0.210			H_4	–0.196	
	C_9	–0.570			H_5	–0.410	
D	D_2	–0.346	–0.216	I	I_3	0.659	–0.408
	D_3	–1.015					
	D_4	–0.382		J	J_2	–0.167	0.015
Constant term		Multiple correlation coefficient r			Coefficient of determination r^2		
0.308		0.949			0.891		

$$F_1 = 0.308 - 1.570A_1 + 0.029A_2 + 0.526B_1 + 0.551B_2 + 0.231C_2 + 0.543C_3 - 0.144C_4 - 0.285C_5 + 1.068C_6 - 0.545C_7 + 0.210C_8 - 0.570C_9 - 0.346D_2 - 1.015D_3 - 0.382D_4 - 0.310D_5 - 0.017D_6 + 0.653E_3 + 1.039E_4 - 0.375F_2 + 0.533F_3 + 0.101G_1 - 0.085G_3 - 1.244H_1 - 0.146H_2 - 0.196H_4 - 0.410H_5 + 0.659I_3 - 0.167J_2 \quad (5)$$

$$F_2 = 0.082 + 0.710A_1 + 0.671A_2 - 0.240B_1 - 0.865B_2 - 0.405C_2 + 0.301C_3 - 0.037C_4 - 0.249C_5 - 0.528C_6 + 0.101C_7 - 0.234C_8 + 0.491C_9 + 1.168D_2 - 0.367D_3 - 0.081D_4 + 1.123D_5 + 0.343D_6 + 0.155E_3 + 0.113E_4 + 0.440F_2 + 0.350F_3 - 0.044G_1 - 0.142G_3 + 0.198H_1 - 0.094H_2 + 0.620H_4 + 0.138H_5 - 1.203I_3 + 0.016J_2 \quad (6)$$

Model validation

The partial correlation coefficient and coefficient of determination indicate the responsiveness of the predictive model to the design elements of trench coat samples. Complex correlation coefficient $R = 0.949$ and coefficient of determination $R^2 = 0.891$ for perceptual factor 1 (F_1); complex correlation coefficient $R = 0.741$ and coefficient of determination $R^2 = 0.548$ for perceptual factor 2 (F_2); the complex correlation coefficients R of the two factors are greater than 0.5, and the coefficients of determination R^2 are greater

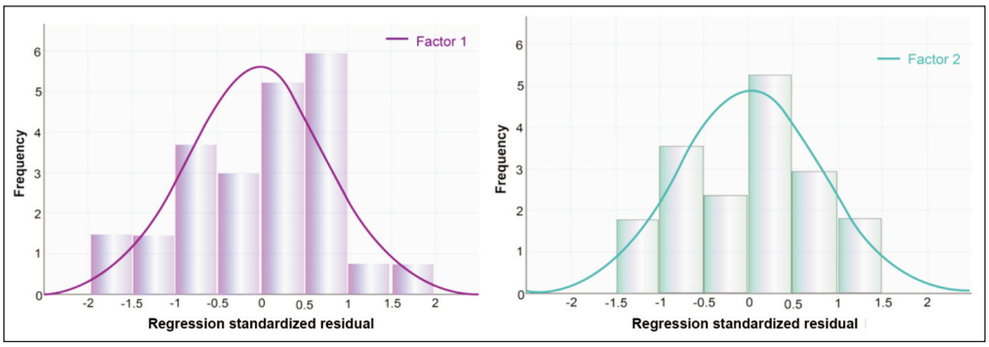

Fig. 4. Histogram of Normalised of the factors

Fig. 5. Trench coat design drawings

than 0.25, which indicates that the prediction equations of two groups of image adjectives have a good degree of fit [26]. Hence, the correlation between the perceptual image of a trench coat and design elements can be analysed. Using SPSS to plot the histogram of normalized of the normalised factors, as shown in figure 4, reveals that the residual distribution adheres to the principles of normal distribution. Thus, the predictive model proves to be valid and feasible.

Application example validation

A woman's trench coat, designed with avant-garde style and unique features, integrates consumer demand. Figure 3 indicates that this style primarily occupies the fourth quadrant, characterised by a loose silhouette and an asymmetrical structure. The waist and cuffs incorporate adjustable fasteners, while the collar features a three-dimensional cape design. Overall, the trench coat exudes a distinct, fashionable flair. As shown in figure 5. Table 1 extracts the style elements of the trench coat, leading to the compilation of a style feature set U. Based on quantitative theory 1, the response matrix B for the trench coat design elements is computed as follows:

$$U = \{A_3, B_2, C_7, D_2, E_4, F_3, G_2, H_1, I_2, J_2\}$$

$$B = \{0,0,1,0,1,0,0,0,0,0,0,1,0,0,0,1,0,0,0,0,0,0,0,$$
$$1,0,0,1,0,1,0,1,0,0,0,0,0,1,0,0,0,1\}$$

Finally, by employing the predictive models developed from factor 1 and factor 2, the calculations yield $F_1 = 0.788$ and $F_2 = -0.04$. These factor scores correspond to the two-dimensional phase limit distribution diagram in figure 3, placing the trench coat in the fourth quadrant, which aligns with the avant-garde, unique, and casual style criteria. This evidence demonstrates that the mathematical model effectively matches and reflects consumer preferences for style, with high accuracy and validity.

$$F_1 = 0.308 + 0.551 + 0.545 - 0.346 + 1.039 + 0.533 - 1.244 + 0.659 - 0.167 = 0.788$$

$$F_2 = 0.082 - 0.865 + 0.101 + 1.168 + 0.113 + 0.350 + 0.198 - 1.203 + 0.016 = -0.04$$

CONCLUSION

This research analyses the mapping relationship between consumers' perceptual image and female trench coat design elements. With the help of Kansei engineering to determine the research sample of trench coat, to obtain the perceptual evaluation and characteristics of the style, and further combined with the research method of quantitative theory I, the conclusion is as follows: Factor analysis reveals two main components, "charm factors" and "personality factors". Subsequently, a two-dimensional phase limit distribution diagram is constructed. Combined with the quantitative theory I, a female trench coat style prediction model is constructed. The model is validated through actual cases. The results show that the model can effectively realise the conversion between consumers' perceptual needs and the design elements with high accuracy and credibility. Through Kansei engineering and quantitative theory, the mathematical prediction model can match and validate the perceptual styles in the form of mathematical formulas, which can help enterprises efficiently integrate the design elements styles and users' perceptual needs, at the same time, reduce the ambiguity and subjectivity in the process of designing, to more efficiently design trench coat styles to meet the customers' perceptual needs.

By combining Quantitative Theory I with Kansei Engineering, this study proposes an innovative research framework that quantitatively reveals the relationship between emotional factors and trench coat design elements, thereby deepening the understanding of consumers' emotional needs. Compared with traditional sentiment analysis methods [8, 10], this approach more precisely quantifies the association between emotional needs and design elements, bridging the gap between subjective emotional assessment and the objective design process. As a result, it enables designers to predict consumer preferences more effectively. The applicability of affective design principles is further validated through real consumer case studies [23], addressing the mismatch between individualised consumer needs and trench coat style design [28]. However, early studies often failed to account for the diversity of individual consumer preferences [33]. By establishing a quantitative theoretical model to address the limitations of

previous Kansei Engineering research, this study more accurately reflects the emotional needs of different consumer groups and enhances the scientific rigour and practicality of design decision-making.

This study fails to adequately explore the preferences of different consumer groups for trench coat styles. There are significant differences in aesthetic standards, style preferences and acceptance of design elements among different groups of consumers. Factors such as consumers' age, body type, personality, and income play a key role in choosing trench coat styles. Future research should focus on segmenting the consumer market and exploring how these factors influence consumers' choice of trench coat styles, to provide consumers with more precise and personalised style design choices. In addition, this study focused on the trench coat as a clothing category and used a uniform treatment of fabric texture and colour grayscale. However, there is a high degree of diversity in the styles, patterns, colours, and fabric types of trench coats in the market. Therefore, future research could extend to other apparel types and introduce more design elements, such as pattern, fabric material, and colour, to explore the effects of these factors on the perceptual evaluation of styles. Future research should further fine-tune the analysis of the role of these design elements on consumer preferences to fully understand the style needs of consumer groups. This will help develop design strategies and theoretical models that are more in line with market demands and adapt to changes, which will not only provide the apparel industry with a more accurate framework for design decisions but also provide designers with more precise and personalised design strategies.

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