Aesthetic Influences of Different Functional Elements Layout on Shopping Website Interfaces

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ABSTRACT

In order to objectively evaluate the aesthetic influence of the layout of different functional elements on mobile phone client interface of shopping websites, five aesthetic indexes were extracted and quantified including balance, sequence, unity, simplicity and density. The analytic hierarchy process, questionnaire method and user interview were introduced to calculate the weight of each index in different functional elements, and a synthetic aesthetic evaluation method of layout design for different functional elements was proposed. Taking the home page interface of four popular Chinese online shopping apps as an example, this paper verifies the objectivity and accuracy of the method for measuring the impact of different functional elements layout on interface beauty, and reflects the influence of each index on the aesthetic of the whole interface, which will be of instructive significance for future design.

Keywords: Interface Design, Analytic Hierarchy Process, Aesthetic Index, Design Evaluation

INTRODUCTION

In today's prosperous information age, e-commerce in China is booming. Online shopping ecosystem has experienced nearly 11 years of accumulation. The past decade has witnessed a dramatic increase in the number of users, from a few number in the beginning to nearly 300 million at present. In addition to the promotion and brand marketing strategy, shopping website design also plays an important role [1].

The rationality of shopping website interface layout not only affects the user's visual experience, but also affects the efficiency of user shopping and platform work [2]. With the development of the times, the aesthetic needs of users are changing. Designers should follow the development trend of the times, tap the needs of users, and constantly improve the design of online shopping page.

In their paper, NGO and others [3] elaborated an intuitive and relatively reasonable method to evaluate interface beauty, and proposed 14 indicators to quantify the aesthetic of interface layout. However, it is not easy to apply all of the indicators in practical cases. At the same time, the relative importance of aesthetic indexes is not exactly the same in different functional blocks, which may have a certain impact on the objectivity of the calculation results of interface beauty.

Through user interview and focus groups of designers, according to the characteristics of online shopping app interfaces, five of the most critical evaluation indexes were selected from the 14 aesthetic evaluation indexes proposed by NGO and his partners. Home pages of four popular Chinese online shopping apps were chosen as the samples of this study. The four home page interfaces were decolored and simplified in Photoshop, and the layout data was inputted into MATLAB to get their respective aesthetic index evaluation scores. Based on the hierarchical structure model, target users compared the importance of the five functional blocks and the five aesthetic evaluation indicators of the interface through questionnaires. After that, discriminant matrices were obtained, used to calculate the weight of each function element after passing the consistency test. The analytic hierarchy process results was used in the case analysis later.

SAMPLE SELECTION

The samples selected in this study are home page interfaces of four popular Chinese online shopping apps which are Taobao, JD, Kaola and PDD. In order to avoid the influence of color on interface beauty, each page was decolored first. Then, each interface was divided into five functional blocks: search bar, advertisement, category menu, product recommendation and function page selection. These areas were separately simplified as minimized rectangular blocks with different colors.

Table 1: Achromatic and simplified home page interfaces of online shopping apps

Taobao	**JD**	**Kaola**	**PDD**
			

AESTHETIC EVALUATION INDEXES

In order to ensure the objectivity of the evaluation results, subjective and abstract words were deleted. Through user interview and focus groups, combined with the characteristics of online shopping app interfaces, five indexes were selected.

Balance

Balance measures the visual stability of each functional block in the overall layout of the interface, as well as the rationality in area and distribution, so as to avoid visual fatigue and information omission. Balance is achieved by obtaining an equal weight of elements on both horizontal and vertical axes and is given by

$$BM = \frac{|BM_{vertical}| + |BM_{horizontal}|}{2} \in [0,1] \quad (1)$$

$BM_{vertical}$, $BM_{horizontal}$ respectively stand for the vertical and horizontal balances with

$$BM_{vertical} = \frac{w_L - w_R}{\max(|w_L|, |w_R|)} \quad (2)$$

$$BM_{horizontal} = \frac{w_T - w_B}{\max(|w_L|, |w_B|)} \quad (3)$$

$$w_j = \sum_i^{n_j} a_{ij} d_{ij} \ , \ j=L,R,T,B \quad (4)$$

where L, R, T and B represent the left, right, upper and lower regions of the interface respectively. a_{ij} represents the area of the element in region j. d_{ij} represents the distance between the midline of the element and the midline of the interface. n_j represents the number of elements in region j.

Sequence

Sequence measures the logical relationship between the layout of different functional

blocks. Sequence is achieved by providing users with positive visual guidance and is given by

$$SQM = 1 - \frac{\sum_j UL,UR,LL,LR \left| q_j - v_j \right|}{8} \in [0,1] \quad (5)$$

$$\{q_{UL}, Q_{UR}, Q_{LL}, Q_{LR}\} = \{4,3,2,1\}. \quad (6)$$

$$v_j = \begin{cases} 4 & w_j \text{ is the maximum in w} \\ 3 & w_j \text{ is the second largest in w} \\ 2 & w_j \text{ is the third largest in w} \\ 1 & w_j \text{ is the minimum in w} \end{cases}, j = UL, UR, LL, LR \quad (7)$$

$$w_j = q_j \sum_i^{n_j} a_{ij}, \ j = UL, UR, LL, LR \quad (8)$$

where UL, UR, LL and LR represent the upper left, upper right, lower left and lower right areas of the interface respectively, and each area is given a visual weight. a_{ij} represents the area of interface element i in quadrant j.

Unity

Unity measures the compactness and consistency of the layout of each functional block. A good sense of unity is conducive to creating the overall style of the interface and improving user familiarity. The formula is

$$UM = \frac{|UM_{form}| + |UM_{space}|}{2} \in [0,1] \quad (9)$$

UM_{form} refers to the degree of association of objects in size with

$$UM_{form} = 1 - \frac{n_{size} - 1}{n} \quad (10)$$

UM_{space} measures the relationship between the space left at the margin and the space between different components with

$$UM_{space} = 1 - \frac{a_{layout} - \sum_i^n a_i}{a_{frame} - \sum_i^n a_i} \quad (11)$$

where a_i is the area of the element, a_{layout} is the area of the design area and a_{frame} is the area of the overall interface. n is the total number of elements.

Simplicity

Simplicity measures the brevity of the layout of each functional block, so as to avoid the burden of understanding and memory. The formula is

$$SMM = \frac{3}{n_{vap} + n_{hap} + n} \in [0,1] \quad . \tag{12}$$

where n_{vap} and n_{hap} represent the number of alignment points in the vertical and horizontal directions respectively, and n is the number of all elements in the interface.

Density

Density measures the degree of tightness of each functional block layout. A research of Zhou Lei and her partner [4] shows that when the interface element density is 50%, the interface layout makes people feel the most comfortable. The formula is

$$DM = 1 - 2\left|0.5 - \frac{\sum_i^n a_i}{a_{frame}}\right| . \tag{13}$$

where a_i and a_{frame} are the area of each element and the whole interface respectively; n is the number of elements in the interface.

AESTHETIC EVELUATION MODEL

AHP uses mathematical model and psychology to provide quantitative basis for analysis and decision-making. It is helpful for decision-makers to find out the best decision and have a better understanding of the problems [5].

In order to further clarify the importance relationship between the different aesthetic evaluation indexes and the influence of each functional block on the overall beauty of the interface, this paper will use analytic hierarchy process to calculate the weight of each functional block on the overall beauty of the interface and the weight of each evaluation index in every functional block. A comprehensive beauty calculation model of interface element layout is built in the end.

Construction of Hierarchical Structure Model

The evaluation index system constructed in this study includes 1 target layer, 5 first-level index layers and 5 second-level index layers, as shown in Figure 1.

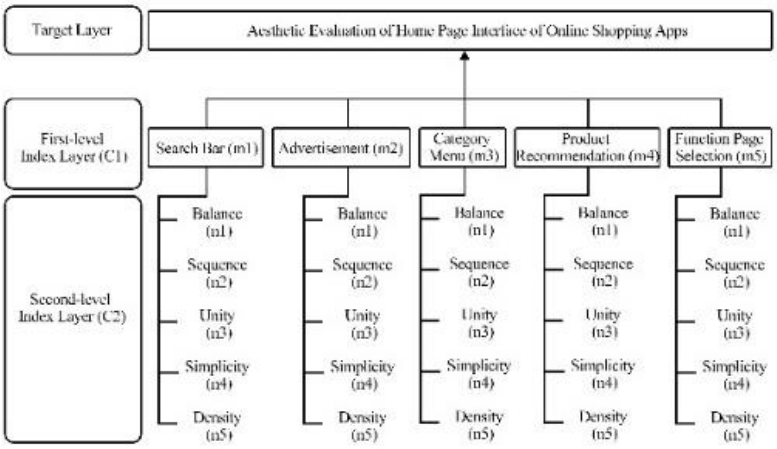

Figure 1. Hierarchical structure of aesthetic evaluation for home page interfaces of mobile client online shopping apps

Construction of Discriminant Matrix

In order to increase the accuracy of importance discrimination, questionnaire survey was used to obtain the relative importance of factors. The questionnaire was distributed through social software, and the participants scaled the importance of each factor of the two indicator levels from 1 to 9. People of all ages with online shopping experience were invited. According to the questionnaire content filled in, AHP is used to calculate the weight of each point at each level. By comparing the importance of each factor in the same layer to a factor in the upper layer, a discriminant matrix is formed.

Assuming that the criterion level factor C_K is related to its next level factor m1, m2, …, m_n, the importance of M_I and M_J to C_K is compared. Then a weight matrix can be obtained with

$$C=(c_{ij})_{n\times n} \tag{14}$$

According to importance, the matrix is assigned 1-9 values. Among them, c_{ij} is the proportional scale of factor m_i and m_j. The meaning of each scale is shown in Table 2.

Scale	Meaning
1	Equally preferred.
3	Slightly preferred.
5	Well preferred.
7	Very well- preferred.
9	Extremely preferred.
2, 4, 6, 8	Median values.
1/1, 1/3, 1/5, 1/7, 1/9	Reciprocal values.

Figure 2. 1-9 scale

Consistency Test

To ensure the authenticity of the data, consistency test is used to verify the validity of the questionnaire. 79 questionnaires were collected, while 57 of them were qualified in the consistency test. The proportion of valid questionnaires was 72.15%. Therefore, it is necessary to test the consistency of the discriminant matrix [6].

The formula of consistency is

$$CR=\frac{CI}{RI}, \quad CI=\frac{\lambda_{max}-n}{n-1} \tag{15}$$

where λ_{max} is the largest eigenvalue of the matrix. n is the order of the discriminant matrix. RI is the average random consistency index of the matrix, which is 1.12 in this research. When CR < 0.1, it is considered that the inconsistency can be accepted and will not affect the qualitative results of ranking [6].

According to the weight value of the comparison matrix established above, the CR value of the discriminant matrix of the first level index layer is 0.0884; the CR values of the five discriminant matrices of the second level index layer are 0.0954, 0.0709, 0.0600, 0.0976 and 0.0944 respectively, which are all less than 0.1. Therefore, the consistency of the discriminant matrix is acceptable.

Weight Calculation

The result of Analytic Hierarchy Process is shown in Figure 3.

From the perspective of functional blocks of online shopping interface, the layout of search bar has the greatest impact on aesthetic feeling of interfaces. Combined with the later user interviews, it is found that the weight ranking is related to the frequency

and demand of users for different functional blocks.

From the aesthetic evaluation index of each functional block, the same evaluation index has different influence on different functional blocks.

C_1 Layer	C_2 Layer	Peer Ranking	Weight	Total Ranking
Search Bar (0.43)	Balance (0.24)	2	0.1032	3
	Sequence (0.04)	5	0.0172	15
	Unity (0.11)	4	0.0473	7
	Simplicity (0.15)	3	0.0645	5
	Density (0.46)	1	0.1978	1
Advertisement (0.10)	Balance (0.24)	2	0.0240	12
	Sequence (0.04)	5	0.0040	24
	Unity (0.11)	4	0.0110	18
	Simplicity (0.15)	3	0.0150	16
	Density (0.46)	1	0.0460	8
Category Menu (0.06)	Balance (0.24)	1	0.0144	17
	Sequence (0.04)	5	0.0024	25
	Unity (0.11)	4	0.0066	23
	Simplicity (0.15)	3	0.0090	21
	Density (0.46)	2	0.0096	20
Product Recommendation (0.25)	Balance (0.24)	3	0.0425	9
	Sequence (0.04)	1	0.1275	2
	Unity (0.11)	2	0.0550	6
	Simplicity (0.15)	4	0.0175	14
	Density (0.46)	5	0.0100	19
Function Page Selection (0.17)	Balance (0.24)	2	0.0408	10
	Sequence (0.04)	5	0.0068	22
	Unity (0.11)	4	0.0187	13
	Simplicity (0.15)	3	0.0255	11
	Density (0.46)	1	0.0782	4

Figure 3. Analytic hierarchy process result

CASE ANALYSIS AND CONCLUSION

The comprehensive aesthetic scores of the four samples are as follows: PDD (0.4729) > Kaola (0.4526) > Taobao (0.3979) > JD(0.3914). The search bar of PDD is the most concise and symmetrical, with only one element block. Different from the scattered layout of the other three pages, the small scanning function icon of PDD is included in the search bar, which makes it more holistic. Taobao, Kaola and PDD all have only one element in advertisement area, showing a strong sense of unity. However, JD has many scattered advertising blocks, which interferes with the overall layout logic of the page and affects the overall beauty and work performance. In addition to PDD,

the category menus of other sample interfaces are composed of two element blocks located in the top and middle of the page, which have little impact on the beauty of the interface. Product recommendation has a great impact on the work performance of online shopping home page. PDD, Taobao and Kaola relatively have a large proportion in this part, which can better provide the corresponding needs for users. However, the product recommendation area of JD is small, and the sense of unity is weak. There is little difference in the selection area of the function page of these four sample interfaces.

The research method has certain objectivity and accuracy for measuring the influence of different functional block layout on the level of interface beauty, and can reflect the influence of a single evaluation index on the comprehensive beauty in different functional blocks. However, there are still some deficiencies in this study. For different types of online shopping apps, the influence of the same aesthetic evaluation index in the same functional area is different. For different functional blocks with different requirements, the most influential aesthetic evaluation index is sometimes different. We need to do further research in the future.

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