The influence and evaluation of commercial building indoor environment on customer satisfaction: Cases from supermarket of northeast China

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Abstract. The purpose of this paper is to establish an analysis and evaluation model of customer satisfaction which is combined with the indoor environment actual characteristics of supermarkets in Northeast China. The author used a standardized questionnaire to gather data, which was conducted in 9 supermarkets in Northeast China. A set of evaluation index system of customer satisfaction was established through using factor analysis tool, and the weight of each index was calculated based on AHP, and Google SketchUp was used to analyse the effects of the design factor on the customer satisfaction. The results show that customers in this region are particularly concerned about the quality and price of the product itself. The two factors of design and background have greater weight because of their direct influence on customers' shopping experiences. The condition of the product will directly affect the satisfaction evaluation. Customers prefer regularly arranged functional areas, sufficient space for traffic and a sufficient number of entrances/exits.

1. Introduction

In recent years, the rapid development of e-commerce has substantially impacted the development of offline supermarkets. To enhance the customer shopping experience and improve customer satisfaction, some famous large e-commerce group enterprises (Alibaba, Jingdong mall, etc.) have actively expanded their offline store entities. Theoretical research on customer satisfaction is relatively mature and has many applications in different fields in China. However, given the indoor environment characteristics of traditional supermarkets, there are few studies on customer satisfaction. The concept of customer satisfaction was first proposed by Cardozo[1], who noted that customer satisfaction affects the willingness to purchase. Over the next 20 years, some scholars have studied only the concept of customer satisfaction[2-3].Other scholars try to discuss customer satisfaction from different single or multiple perspectives with environment[4-6]. Professor Fornell built a complete customer satisfaction evaluation index (CSEI) based on previous theories and research[7].The Swedish Statistics Bureau designed the earliest national customer satisfaction scale (SCSB) based on the model by Professor Fornell. The SCSB sets up an evaluation model of customer expectations and perceives value as an independent variable and customer satisfaction as a dependent variable. The American customer satisfaction index (ACSI), released in 1994, has made great improvements The advantage of this improvement is that it distinguishes the value perception driven by product quality, improves product reliability, and focuses on the influence of customization on product quality, thereby increasing the customer expectation measurement method from one indicator in SCSB to three (including the overall reliability and customization). In addition, a specific measure of price tolerance was added to the ACSI. The European customer satisfaction index (ECSI) was formulated in 2000.

Based on the ACSI, the ECSI adds corporate image and further divides perceived quality into two parts: “hardware” and “software” [8]. In addition, the CSEI (ACSI/ECSI) evaluation system has been widely adopted and applied to all kinds of industries[9-11]. Clearly, the application of the ACSI/ECSI system is still very broad in the indoor environment satisfaction evaluation[12-13]. Related research on customer satisfaction evaluations of supermarkets in Northeast China has not been discussed.

2. The establishment of customer satisfaction evaluation model on indoor environment

2.1. Index model

The customer satisfaction score is named S, and the first-level index is expressed as F_i; its factor load is a_i, where i=1,2,3……. The second level index is expressed as f_j, and the corresponding factor load is b_j, where j=1,2,3…….The customer satisfaction evaluation model is as follows:

$$S = a_1F_1 + a_2F_2 + a_3F_3 + \ldots\ldots + a_iF_i \quad (1)$$

Under the first-level index, the second-level index load model is as follows:

$$F_i = b_1f_1 + b_2f_2 + b_3f_3 + \ldots\ldots + b_jf_j \quad (2)$$

2.2. Customer satisfaction index of the supermarket

According to the related scholars’ literature reviews, this index system uses six aspects: corporate image, customer expectation, service quality, design factor, background factor and product factor. Many large supermarkets of a similar size (more than 5000 square metres) are selected in the provincial capital city of Northeast China. The survey began on October 20, 2017, and ended on November 5, 2017. A total of 9 supermarkets were investigated. The investigation task was completed by 3 training student teams containing 6 people. The author used phone calls to confirm the validity.

In this survey, 520 questionnaires were issued, and 439 valid questionnaires were returned. A reliability analysis of the effective questionnaire was carried out. Cronbach's alpha coefficient was calculated as 0.942. The reliability of the questionnaire increased to 0.943 after the deletion of the sixth question on service quality. By using the factor analysis tool of the second-level index in SPSS 22.0, the first-level index of the customer satisfaction evaluation was generated. Since the KMO value of 0.939 exceeds 0.7, there is a data reduction problem. The Bartlett spherical test value is less than 0.0001. From the factor analysis of the second-level factor, six factor eigenvalues are greater than 1, and the cumulative explanatory variance exceeds 50%, as shown in table 1.

Table1. The result of factor analysis

Influence factor	Total	% of Variance	Cumulation %
Factor1	3.064	13.927	13.927
Factor2	3.016	13.710	27.636
Factor3	2.691	12.232	39.868
Factor4	2.057	9.352	49.220
Factor5	1.869	8.498	57.718
Factor6	1.838	8.353	66.070

According to the factor load matrix, we know the second-level index variables, which are included by factor; we name these factors as F1 to F6.In summary, the customer satisfaction evaluation system for supermarkets in Northeast China is constructed. The structure is shown in table 2.

Table2. The evaluation index system

First level index	Second level index
Customer Expectation	The impression of the supermarket(including the Popularity)
	The participation of public welfare & the performance of responsibility
	The condition of the product expected by customer
	The condition of the service expected by customer
Product Economy	The same product compared with competitors
	Product Price
	Promotion and membership activities

Product Quality	The variety of the product The safety of the product The brightness of the product
Service Quality	Employee service timeliness（including personalized service） Employee standard（including proficiency and attitude） The service facilities
Design Factor	The design of transportation space The design of function space The inner design The facility design（such as lockers / trolly / elevator / fire protection） The payment design (including POS / cash / check /QR code)
Background Factor	The comfort degree of color collocation The comfort degree of inner temperature The comfort degree of background sound（including music/noise） The comfort degree of inner air

3. Empirical analyses on the customer satisfaction of the supermarket indoor environment

3.1. A brief introduction to analytic hierarchy process

In the 1980s, Saaty created the AHP (Analytic Hierarchy Process,)[14]. The AHP pulls apart the main problems and integrates the solution of the sub-problem to reach a conclusion. The subjective component of the evaluation result is obvious only if a qualitative analysis is carried out without any quantitative evaluation. The AHP method enables decision makers to resolve complex problems in a hierarchical structure by following certain steps and measures a large number of qualitative and quantitative factors systematically[15].

The basic principle of the weight formation of the AHP method is as follows:

The basis of the AHP determination of weight method is the single-criterion AHP construction method. I1, I2,…In is the n item of the judgement matrix, and the detailed construction weight process is described as follows. The first step is to determine the proportion judgement matrix of the comparison among the 22 indexes, which is recorded as A. The proportion of the nine-scale system is used. The value of the weight vector and the specific process of the calculation are as follows:

Step 1: Calculating the geometric average value G_i of matrix A (I is the line number, i=1,2... N). The formula is:

$$G=\sqrt[n]{a_{i1}\times a_{i2}\times a_{i3}\times \ldots \times a_{in}}=\sqrt[n]{\prod_{j=1}^{n} a_{ij}} \quad (i=1,\ 2,\ \ldots,\ n) \tag{3}$$

Step 2: The geometric evaluation value G_i and the weight w_i are obtained in the normalization step 1. The formula is:

$$W_i=\frac{G_i}{\sum_{j=1}^{n} G_i}\ (i=1,2,\ldots,\ n) \tag{4}$$

The calculated weight vector is as follows: $w=(w_1\ \ w_2\ \ \ldots\ \ w_n)^T$.

Step 3: Based on step 2, the w calculation judgement matrix A is the maximum eigenvalue λ_{max}, which builds a good foundation for the subsequent consistency test.

$$\lambda_{max}=\frac{1}{n}\sum_{i=1}^{n}\frac{(Aw)_i}{w_i} \tag{5}$$

$(Aw)_i$ is the i^{th} element of Aw.

The formula for the consistency ratio (CR) is as follows:

$$CI=\frac{CR}{RI} \tag{6}$$

The largest eigenvalue of the A matrix is λmax. Therefore, all positive judgement matrixes A have λmax≥n, and the degree of consistency A is high. The closer the value of the λmax is to n, the higher

the degree of consistency of the judgement. Therefore, the smaller the value of CI, the higher the consistency of the judgement matrix A. In general, it is feasible that the CR is CR≤10%. Otherwise, CR needs to be recalculated.

3.2. The weight calculation of each level index

According to the above method, through back-to-back expert scoring, the results are input into the ExpertChoice2000 to calculate the weight of each level index: Product Quality 0.330, Product Economy 0.175, Service Quality 0.065, Background Factor 0.184, Design Factor 0.162, and Customer Expectation 0.084. All the matrixes pass the consistency test.

Similarly, the weight of the six groups of second-level indexes was calculated, and the consistency test was carried out for each one. The evaluation structure and the corresponding weight at various levels are shown in Figure 1 below.

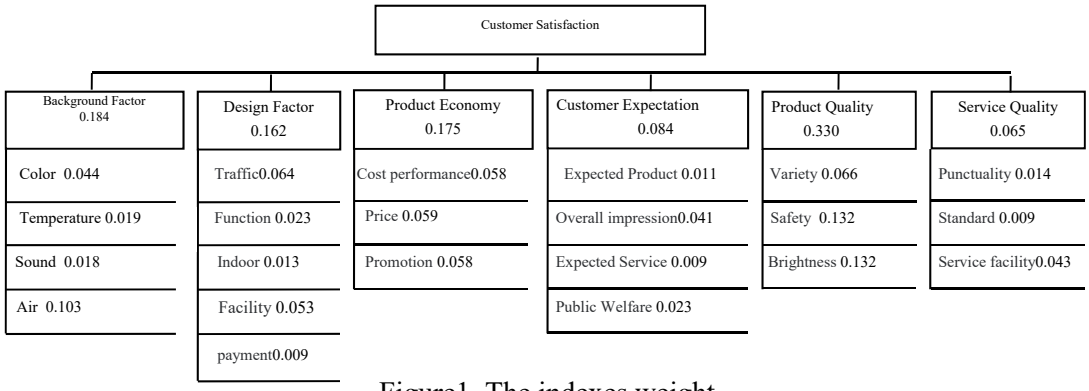

Figure1. The indexes weight

3.3. Evaluating and ranking of 9 typical supermarkets in northeast China

According to the age distribution, the survey is representative. The ages of the surveyed customers are close to the normal age distribution, and the age distribution of the whole population is similar to that in Northeast China. Of the respondents, the majority are 18- to 35-year-old customers (222 people), followed by the 36-50 age group (130 people). Regarding purchasing frequency, more than 250 people shop 1-2 times a week, followed by 150 people who shop 3-5 times a week. The occupation distribution of the survey respondents is relatively uniform. Most respondents are students, enterprise employees, and government and public institution employees. The total number of respondents in these three categories is 329.

The evaluation index model of satisfaction with supermarkets in Northeast China was used to evaluate 9 typical supermarkets in this survey. The mean value of the scores of the two-level indexes corresponding to the investigated problems is used in the formula of the second-level index load model (2), and the consequence is the score of the first-level index. Then, the score is brought into the customer satisfaction evaluation model formula (1) and is used to calculate the score of the supermarket. The results of the final satisfaction scores are shown in table 3.

Table3. The final score of each supermarket

Market	Background Factor	Design Factor	Product Economy	Customer Expectation	Product Quality	Service Quality	Centesimal Score
A	4.377	4.339	4.108	4.393	4.340	4.232	86.0730
B	4.107	3.975	3.591	4.193	4.234	3.931	80.669
C	3.784	3.925	3.629	4.209	4.240	3.941	79.532
D	3.846	4.013	3.733	4.097	4.114	3.811	79.225
E	3.797	4.016	3.619	4.029	4.132	3.833	78.681

F	3.828	3.684	3.549	3.969	4.057	3.910	76.983
G	3.893	3.960	3.493	3.900	3.873	3.821	76.477
H	3.724	3.595	3.505	3.551	3.775	3.674	73.286
I	3.518	3.683	3.155	3.711	3.786	3.464	71.654

3.4. The analysis of significant differences among the indoor environment factor

Through the analysis of the data, it is found that the difference in the design factor score is significant. The author uses Google SketchUp to build a three-dimensional model for visualizing the design factor, as shown in Figure 2 below.

Market H, as shown in H in the figure 2, shows that the distribution of functional areas in H is rather chaotic, which is poor in the setting of traffic space. According to the recommendation standard of building architecture, the minimum width of a single person is 550mm. The two-way corridor should be considered in the supermarket aisle setting, so the width of the aisle should not be less than 1200mm. In the H supermarket, there is no main aisle, and the passageway is wide and narrow. In contrast, the supermarket A, as shown by A in the figure, has a clear main aisle and a width of 2500mm. The entrance and exit of the supermarket A is more humanized. In addition to one specific entrance of the supermarket A, the other exits, which locates in nearby facade, share the responsibility of both entrance and payment function. The more significant difference is that 23 checkout counters in the supermarket A, while only 10 counters in supermarket H.

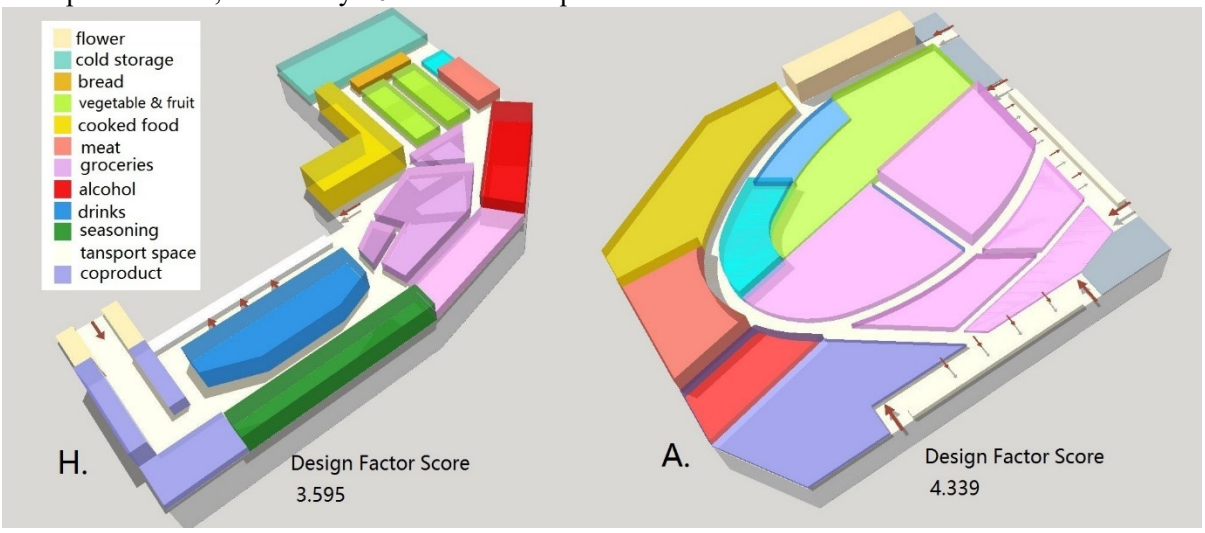

Figure2. The function area design of the supermarket H and A

Obviously, customers prefer regularly arranged functional areas, sufficient space for traffic and a sufficient number of entrances/exits, which are related to the design factor score.

4. Discussions and conclusions

Improving customer satisfaction and increasing profits are the goals of supermarkets. The influence of analysis and evaluation of indoor environment on customer satisfaction in China started relatively recently. We tested the reliability of the questionnaire and conducted a factor analysis of the customer score. This study determined that the characteristics of customer satisfaction in Northeast China are significantly different from those of the conventional index system. Customers in this region are particularly concerned about the quality and price of the product itself, which directly affect how they evaluate their satisfaction with the supermarket. The findings in this paper also verified that service quality is similarly situated with corporate image. Of course, the two factors of design and background have greater weight because of their direct influence on customers' shopping experiences.

The analysis of the 6 first-level factors of the 9 supermarkets found that the design factors were significant different. Based on field measurements and SU software modelling, it was determined that

customers prefer designs that include regularly arranged functional areas, sufficient space for traffic, and customer-friendly entrances/exits.

Focusing on the problem of supermarket environmental quality management in Northeast China, it is suggested that the way to improve the indoor environment and improve customer satisfaction in supermarkets in Northeast China includes the following: (1) The supermarket should Improve customer satisfaction with products. (2) The supermarket should conform to the concept of setting customer demand at the centre of the competition to design safe and comfortable indoor facilities.

In future studies, other multi-criteria methods can be used to address customer satisfaction evaluation problems[16]. The sample size and number of sample cities could be increased to cover more regional supermarkets and more age levels to make the data more representative of the region. By analysing the reasons for the same index scores for supermarkets, we can advance some constructive suggestions regarding the shortage of supermarkets. In addition, for regions with obvious characteristics, structural analysis of the index system should be developed[17], and a set of new systems should be established to enrich the research on customer satisfaction.

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