

A prediction method of consumer behavior transformation in K12 educational institutions

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Abstract: *It introduces a prediction method for the transformation of consumption behavior of educational institutions, namely, the consumption behavior of educational institutions under the LSTM (long-term short-term memory) network. Based on the theory of behavior, this paper predicts the decision-making of consumers, and uses statistical factor analysis and structural equation model to establish the analysis model of the demographic factors affecting the purchase of educational institutions. Relevant data are collected, and software such as SPSS is used for analysis and modeling. Through related tests, the preferences and related latent variables of a certain type of group are revealed. Multi-dimensional analysis, accurate prediction, and one-to-one recommendation are necessary ways for educational institutions to obtain profits and improve consumers' satisfaction.*

Keywords: *K12; Consumers' behaviour research; Structural equation model; Countermeasures*

1. Introduction

In recent years, with the rapid development of China's economy and society, educational institutions have become the focus of attention of many families in China. With the continuous development of economic globalization, the globalization of education is gradually being promoted. Mature foreign educational institutions begin to enter China. The number of independent brand educational institutions in the domestic market is also increasing day by day, which makes the education market extremely competitive [1]. Educational institutions emerge in an endless stream, and a variety of new ideas and methods are used to attract consumers' attention.

Educational institutions should analyze the inherent characteristics of consumers' buying behaviour, such as inherent laws, consumption levels, and personal preferences. It is a challenge for educational institutions to estimate the likelihood of consumers' buying products in educational institutions and to accurately recommend the estimated results [2]. The latest science and technology are introduced into consumers' behaviour analysis, and the accuracy of analysis and prediction is improved. Realizing one-to-one precise suggestions and formulating effective marketing strategies are key issues that need to be resolved urgently. How to effectively analyze consumers' behaviour and accurately grasp consumers' decision is an urgent problem [3].

Starting from the LSTM network, based on the acquired consumer-related data, software such as SPSS is used for analysis and modeling. Related tests are performed, and statistical factor analysis and structural equation models are used. An analysis model of the influencing factors of educational institutions' product purchasers is constructed, which realizes the prediction of consumers' future decisions and provides theoretical and technical references for educational institutions and the formulation of marketing strategy.

2. Method

2.1 Hypothesis and Model Construction

(1) The theoretical basis of the hypothesis

If the relevant behaviours of consumer groups are deeply understood, a corresponding consumers' behaviour framework must be created [4]. As the development of related theories is constantly evolving,

the conclusions of related inquiries from countries around the world need to be integrated. The relevant influencing factors involved have gradually become diversified and systematized [5]. The three major aspects of consumer group behaviour theory are mainly expounded in this section, which are used as the theoretical basis for a deeper discussion.

① Planned behaviour theory

The basic assumption of planned behaviour theory is that individual behaviour is rational. Behaviour motivation is the most direct influencing factor for individuals to implement corresponding behaviours. As long as the factors that may affect the behaviour are all manifestations that directly affect the behaviour through this behavioural motivation [6]. This theory believes that a certain behaviour of an individual is a result of careful thinking by the individual, which is a complex psychological activity. In general, the behavioural intentions of an individual can be determined by three major elements, namely internal elements, external elements, time and opportunity elements.

Planned behaviour theory interprets and infers individual behavioural decisions very well. Therefore, the theory has been widely used after it was put forward [7]. However, when applying this theory, the following issues still need to be paid attention to. First, the rational person assumes that individual behaviour is assumed to be rational and autonomous, which is difficult to achieve in reality. Second, it is assumed that the generation of individual “actual behaviour” must be based on “behaviour intention”, which has no direct relationship with “behaviour attitude”, “subjective norm”, and “perceived behaviour control”. Third, relevant elements such as subjective norms, self-efficacy, and beliefs is paid more attention to. However, various cognitive elements such as individual habits, behavioural strategies, experience and knowledge reserves is neglected [8].

② Value-belief-normative theory

According to this theory, an entity’s environmental behavior is mainly influenced by three main factors, namely, personal values, personal beliefs and environmental protection concepts [9]. Figure 1 is the concrete content of the three elements of the value belief norm. The theory is further divided into five variables: value, New Environmental Paradigm (NEP), result consciousness (AC), attribution of responsibility (AR) and individual norm (PN). These five variables cooperate to form an inseparable causal chain, in which each variable is related to the next variable, and may also be related directly to the variables further downstream in the chain.

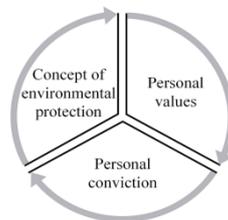


Figure. 1 Three elements of the norm of value and belief

Different values of individuals will lead to different environmental protection beliefs and corresponding individual norms. This will enable individuals to form a corresponding sense of responsibility for implementing environmental protection activities to achieve some specific environmental protection behaviours. Figure 2 shows the research framework of the theory. The theory focuses on strengthening individual values and divides values into three categories: altruistic values, ecological values, and self interest values. Values, a worldview that applies to the new environment, is a different expression of the environment, and that can lead to some of our own ideas about the environment, will think more about environmental phenomena or problems, further produce I do not have the responsibility of environmental protection belief and adhere to this belief, so that we can set some norms and standards of different individuals, help us develop the intention to protect or damage the environment. The theory focuses on strengthening the effects of personal values, and also divides values into three categories. Then the front-end effects of values are studied, which effectively broadens the scope of environmental behaviour research [10]. In addition, Stern also pointed out that in the causal chain, the ways in which each element affected the latter element were also diversified. This approach includes not only direct effects, but also mediating effects, and there may also be skipping effects on the latter element.

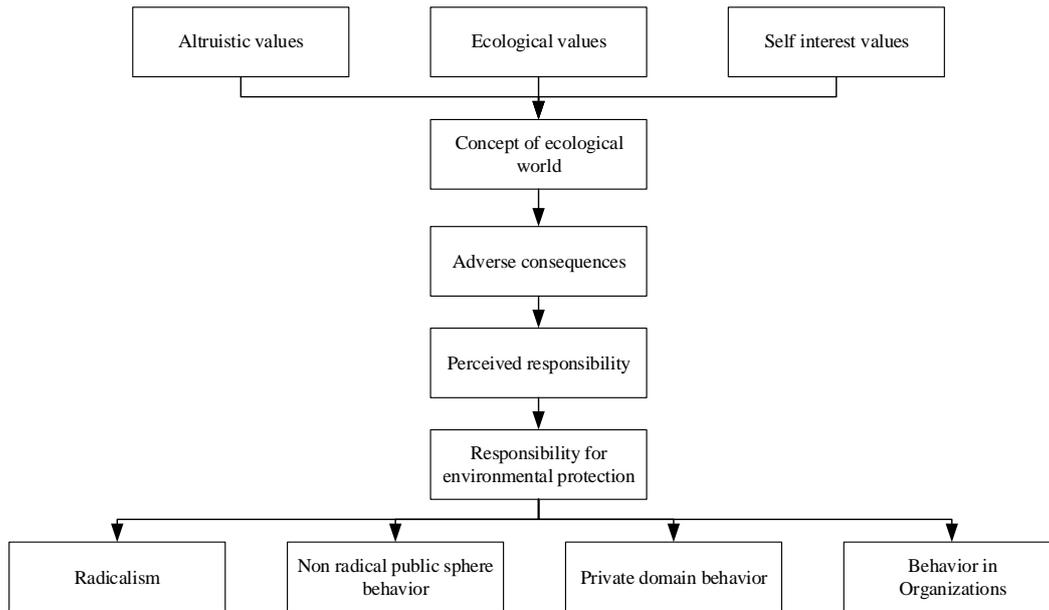


Figure. 2 The Research Framework of Value-belief-normative Theory

③ Multi-factor integration model

The above two theories are mostly based on static thinking to analyze the model, which belongs to the cross section in the time dimension. But in fact, the evolution process of the corresponding decision-making and behaviour change trend of the consumer group belong to a more complex systemic and dynamic process of change. Therefore, scholars try to use the theoretical summaries of the predecessors as the basis and put relevant elements into this framework. The multi-element integration theory proposed by researchers such as Bamberg is the most representative [11]. Figure 3 shows the research framework of the theory. The multi-factor comprehensive model has the following characteristics: first, the analysis of a certain thing is not explained separately according to the order of each index, but is applied to a certain thing by using some different methods. Second, in the process of comprehensive analysis, due to the different degrees of influence of various factors, it is necessary to carry out a certain degree of mathematical weighted sorting. Third, the results of its multi-factor analysis are not concrete enough, it is often necessary to use a more direct index or score to indicate the overall situation of something.

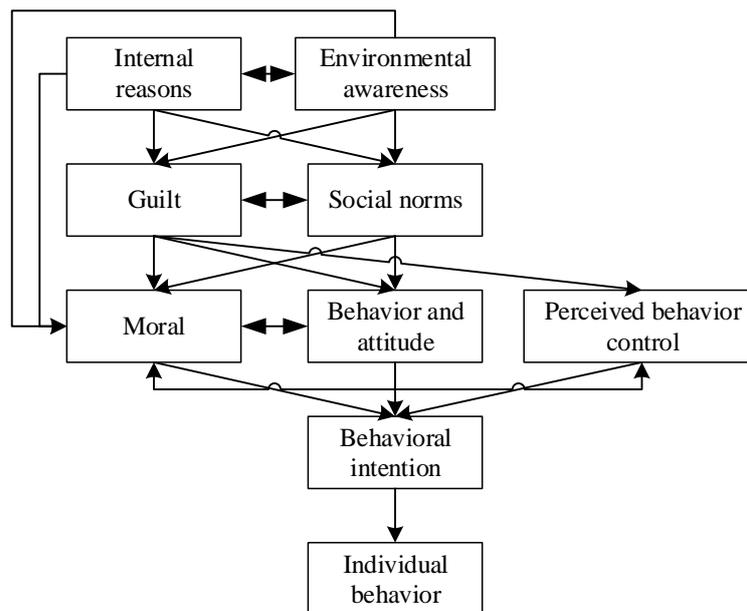


Figure. 3 Research Framework of Multi-factor Integration Model

(2) Hypothesis proposed in the study

By summarizing the above classic theories, according to the actual situation of educational institutions, the following assumptions are made for the research.

① Institutional image

First, the impression of educational institutions in the minds of consumers is the first research factor, and the first hypothesis is put forward. That is to say, the higher consumers' perception of the importance of the image of an educational institution, the higher awareness of the institution's products, and the higher the likelihood that the institution's products will be purchased [12].

Hypothesis 1: The image of educational institutions has a positive impact on product perception.

The variable title designed for "Assumption 1" is:

- > Brand Image of Educational Institution
- > Brand Exposure of Educational Institutions
- > The Scale and Market Share of Educational Institutions

② Cognitive level

The deeper the consumer's awareness of the products of an educational institution, the higher the likelihood that the institution's products will be purchased. Based on this assumption, the design variables are as follows.

Hypothesis 2: Consumers' perceptions of educational institutions' products have a positive impact on consumers' behaviour and attitudes.

The related topics for the "Assumption 2" design are:

- > The Price-performance Ratio of Educational Institution Products
- > Educational Effects of Educational Institution Products
- > Follow-up Service of Educational Institution Products

③ Behaviour attitude

In terms of topic arrangement, whether consumers will buy educational institution products and whether the product is introduced to purchase as a measurement topic to quantify the influence of behaviour and attitude.

Hypothesis 3: Behavioural attitudes have a positive effect on behavioural outcomes.

In response to this assumption, the following titles are designed.

- > I Will Consider Buying Products from Educational Institutions in the Future
- > I Would Be Happy to Recommend Others to Buy if the Educational Institution's Product Is Good

④ Social characteristics

Based on Maslow's hierarchy of needs theory, the needs of the public are hierarchical and phased [13]. Consumer groups have the corresponding resources, or reach a certain stage, and the theory can match the behaviour of consumers buying goods. It is a more effective method to measure and characterize by means of population sociology. Related methods such as age, gender, income level and knowledge level. Sociological characteristics are used as control variables, and different characteristics and different levels of characteristics are analyzed for differences in behavioural results, behavioural attitudes, product cognition and many other aspects [14].

⑤ Behaviour result

Respondents' actual purchases of educational institutions' products are measured.

2.2 Statistical Methods and Models

(1) Factor analysis

Factor analysis is a way to reduce the dimensionality of data. With the current development of Internet

technology, various offline behaviours and data are gradually shifting to online. In the course of this interaction, a lot of data are retained. Therefore, higher-dimensional data can be obtained when studying a certain problem. In this series of variables, some variables will have the problem of collinearity. However, in some cases, certain variables cannot be simply eliminated directly. Although the problem of collinearity is solved, some information is lost in vain [15].

The basic idea of factor analysis is to group the original variables according to the size of the correlation, so that the variables in the group are more correlated, and the correlation in different groups is smaller. Moreover, each newly divided group can be characterized by a “factor” that is not directly observed. These factors have good explanatory properties. The general factor model is expressed as follows.

A sample group is assumed. This sample group has n samples and p feature values. The normalized sample mean μ is 0, and the variance is 1. The variable vector is represented by X , and F_1, F_2, \dots, F_m ($m < p$) represents the common factor of normalization.

① $X = (X_1, X_2, \dots, X_p)'$ is a dominant random vector, the mean is 0, and the covariance matrix is Σ .

② $F = (F_1, F_2, \dots, F_m)'$ ($m < p$) is a non-dominant variable and cannot be observed, its mean vector $E(F)=0$, and covariance matrix $cov(F)=1$.

③ $\varepsilon = (\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p)'$ and F are independent of each other, and mean value is 0, and the covariance matrix is a $\Sigma\varepsilon$ diagonal square matrix.

The factor model is expressed as follows.

$$\begin{cases} X_1 = a_{11} F_1 + a_{12} F_2 + \dots + a_{1m} F_m + \varepsilon_1 \\ X_2 = a_{21} F_1 + a_{22} F_2 + \dots + a_{2m} F_m + \varepsilon_2 \\ \dots \\ X_p = a_{p1} F_1 + a_{p2} F_2 + \dots + a_{pm} F_m + \varepsilon_p \end{cases} \dots\dots (1)$$

(2) Structural equation model

Structural equation model (SEM), also known as covariance structure model, is an important multivariate analysis tool. This model analyzes the relationship between features based on the covariance matrix of feature variables [16]. In many social sciences, economics, finance, psychology, and management studies, there are latent variables that cannot be directly observed, such as learning motivation and user satisfaction. However, traditional statistical methods cannot solve such problems well. The structural equation model has matured in the 1980s and can make up for the shortcomings of traditional calculation methods. For example, the “behaviour and attitude” cannot be directly observed [17].

The structural equation model generally contains two parts. One is the measurement model, and the other is the structural model, which is the relationship model between the latent variables.

① Measurement model

The measurement model is a description of the observable variable, that is, the relationship between the index and the latent variable. For example, “brand image”, “brand exposure”, and “scale and market share” three indicators describe the “image of educational institutions” [18]. The expression equation of the model is shown below.

$$x = \Lambda_x \xi + \delta \dots\dots (2)$$

$$y = \Lambda_y \eta + \varepsilon \dots\dots (3)$$

Among them:

X: Vector of exogenous explicit variables

y: Vector of endogenous explicit variables

Λ_x represents the factor loading matrix, that is, the relationship between the exogenous explicit variable and the exogenous latent variable

Λ_y represents the factor loading matrix, that is, the relationship between the endogenous explicit variable and the endogenous latent variable

ξ : Vector of exogenous latent variables

η : Vector of endogenous latent variables

δ and ε represent the measurement error of x and y respectively

② Structural model

To describe the relationship between latent variables, such as the relationship between “image of educational institution” and “product recognition”, it can be expressed through structural models. The structural equation is shown below.

$$\eta = B\eta + \Gamma\xi + \zeta \dots\dots (4)$$

Among them:

B: Relationship between endogenous latent variables

Γ : The influence of exogenous latent variables on endogenous latent variables

ζ : The residual of the structural equation, which represents the unexplained part of η in the equation

3. Results and discussion

3.1 Empirical Analysis Based on Structural Equation

Structural equation model is a very important multivariate statistical analysis tool, and it is widely used in the research of various disciplines such as economics, psychology, and sociology. Structural equation model integrates two types of statistical analysis methods, factor analysis and path analysis. Based on the covariance matrix, the correlation between the observed and unobservable variables in the model is tested. Therefore, the direct, indirect and total influence of the dependent variable by the independent variable and the degree of influence are obtained [19].

For the data collected this time, the main reasons why the structural equation is selected for analysis include two points.

First, the variables involved are unobservable except for “purchasing products of educational institutions”. That is, these variables are latent variables. For example, behavioural attitudes and product cognition can only be obtained indirectly from the observed variables.

Second, the research is based on three classical behaviour theories and multi-element models. Therefore, compared with other statistical research methods, the research based on this theory is more suitable for structural equation model.

(1) Definition of structural equation variables

An exploratory factor analysis is carried out for the research, and finally, the various factors in this structural equation are summarized as follows.

① Behaviour result

A certain specific behaviour performed by an individual is the result of the actual behaviour, which is used to measure the association with each factor. A certain specific behaviour performed by an individual is actually the behaviour of purchasing products from educational institutions in the research.

② Behaviour attitude

Generally speaking, if an individual has an increasingly positive attitude towards a certain target behaviour, it will be easier to implement the behaviour. In the opposite case, it is easier to give up this

behaviour [20]. “I will buy products from educational institutions” and “Recommend others to buy products from educational institutions” are measured in the study.

③ Product awareness

Product recognition consists of two parts. One is perceptual cognition. In many cases, consumer groups are in a state of asymmetric information about a certain product. Therefore, the consumer group’s perception of the product is often incomplete. Relatively speaking, direct product promotion by the appearance organization of the product will bring perceptual cognition to consumers [21]. The other is rational cognition. Compared with perceptual cognition, rational cognition, in many cases, requires consumers to pay a certain learning cost to understand the product in depth [22].

④ Institutional image

The brand image of educational institutions will have a subtle impact on consumers. The factors forming “brand image of educational institutions”, “brand exposure of educational institutions”, and “scale and market share of educational institutions” are measured.

(2) Construction of structural equation model

The above explanation is summarized, the three behavioural theories are integrated, and the influencing factors of consumer groups in the consumption willingness of educational institutions’ products are summarized. This model better reflects the factors that consumers may be affected or restricted by the product selection of educational institutions, and further validates the ways in which these factors act [23]. The model is shown in the figure below.

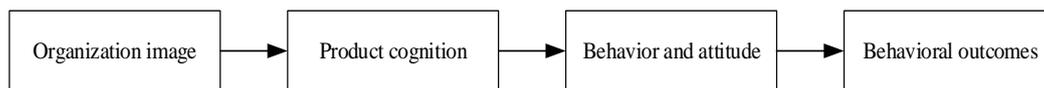


Figure. 4 The Analysis Structure Model of the Influence of Consumer Groups

(3) Distribution of data

Structural equation models also have certain requirements for the distribution of sample variables. The distribution of the relevant sample data should be consistent with the normal distribution to ensure that the parameter estimates will not have excessive deviations. Kurtosis and skewness are usually described for whether a variable is normally distributed. The larger the absolute value of the data, the more significant the non-normal distribution of the corresponding data is reflected [24]. However, in practical discussions, it is more difficult to make all the data fit the normal distribution. Therefore, it has been proposed in some related studies that only a single variable can meet this requirement. The results obtained by the structural equation model by maximum likelihood estimation are still credible [25].

The skewness and kurtosis of the samples were analyzed by SPSS22.0. Skewness, a measure of the direction and degree of skewness of a statistical distribution, is a numerical characteristic of the degree of asymmetry in the distribution of statistical data. The peak degree (peakedness) represents the characteristic number of the peak value of the probability density distribution curve at the mean value. Intuitively, the kurtosis reflects the cuspleness of the peak. In general, the absolute value of skewness is within 2 and the kurtosis is between -1 and 3, and the variables meet the requirements of normal distribution. The minimum value of the skewness of each variable in the sample is -1.623, and the maximum value is -0.621. The minimum value of kurtosis is -0.033, and the maximum value is 2.453. Therefore, the univariate can satisfy the normal distribution, and the structural equation can be used for modeling [26]. The figure below shows the final conclusion of the normal distribution test.

Table 1 Skewness and Kurtosis Statistics

	CX1	CX2	CX3	CR1	CR2	CR3	CR4	XT1	XT2	XT3	XT4	BO1
skewness	-.273	-.286	-.532	-.663	-.651	-.907	-.870	-.369	-.359	-.401	-.205	-.234
peakedness	-.582	-.394	-.248	-.206	-.128	.023	.058	-.100	-.316	-.210	-.678	-.596

To ensure the prerequisites for the structural equation model, the test of normal distribution for each variable mainly includes Kolmogorov-smirnov test and Shapiro-Wilk test, and $P < 0.05$ indicates that the Normality test of normal distribution is normal. The statistical results are shown in Table 2 below. All the variables meet the requirements of normal distribution. each variable is tested for normal distribution. The statistical results are shown in the figure below, and all variables meet the requirements of normal

distribution.

Table 2 Variable Normality test

	CX1	CX2	CX3	CR1	CR2	CR3	CR4	XT1	XT2	XT3	XT4	BO1
Kolmogorov-Smirnov test	0.001	0.000	0.003	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Shapiro-Wilk test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000

(4) Validation of structural equation model

After the model parameter estimates are obtained, the model should be tested and evaluated. The main purpose is to test whether the proposed model is statistically significant and whether it needs to be adjusted. The content of this assessment includes two categories: fitness test and parameter test [27].

① Test of fit

According to the theoretical model and assumptions put forward in the previous article, the corresponding structural equation is established. The AMOS22.0 software is used to implement the relevant analysis of the fitness test. The following figure shows the structural equation model path diagram and some related parameters [28]. In this structural equation, there are 1 external latent variable (organization image), 2 internal latent variables (product cognition, behaviour attitude) and 1 internal explicit variable (behaviour result).

The results of correlation analysis showed that organizational image had a positive effect on product cognition ($\beta = 0.19, p = 0.000$), the effect path of product cognition on behavior and attitude was not significant ($\beta = 0.13, p = 0.074$), and behavior attitude had positive significant effect on behavior outcome ($\beta = 0.38, P = 0.000$). They are shown in the figure below.

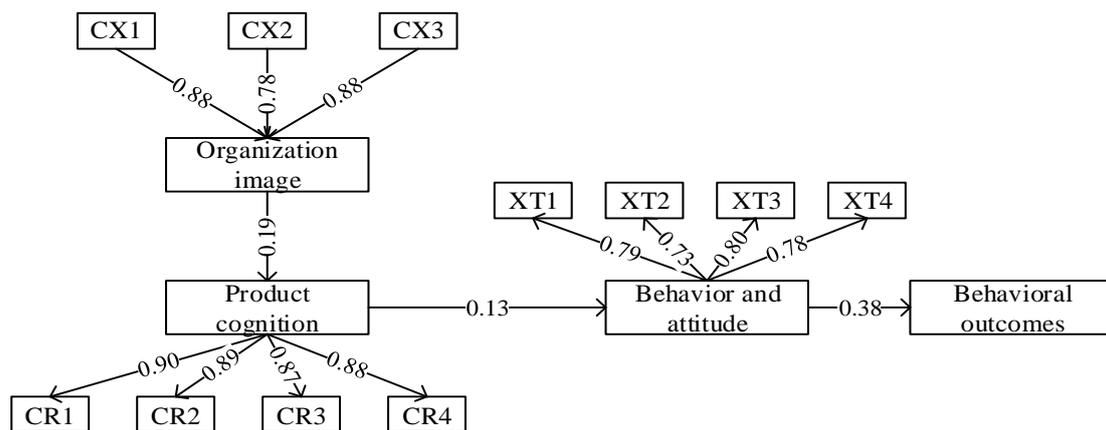


Figure. 5 Structural Equation Path Diagram and Standardized Output Results

② Parameter test

The parameter test refers to the implementation of the test on the significance and rationality of the parameter. The former test mainly uses t-test, and the latter is to test the parameter estimation. For example, whether the error has a negative value, the standard error range is not too large, whether the standard regression coefficient is “ ≥ 1 ”, and whether the relevant parameters can be explained reasonably [29].

In the previous structural model, the error variance values are all non-negative values. The standard error of the variable does not produce an excessively large value. In addition, the absolute values of regression coefficients are all smaller than the required critical value of 0.95, and finally the model passes the parameter test [30].

③ Summary of hypothesis verification

At the beginning of this chapter, relevant assumptions are set. Combined with the structural equation model, the result is obtained. The final results of the related hypothesis verification are described in Table 3.

Table 3 Verification of the Original Hypothesis

Serial number	Hypothesis	P	Is it established?
1	The image of the organization has a positive impact on product perception	0.000	Yes
2	Consumers' perceptions of educational institutions' products have a positive impact on consumers' behaviour and attitudes	0.074	No
3	Behavioural attitudes have a positive impact on behavioural outcomes	0.000	Yes

4. Conclusion

To sum up, the main research content of this paper is consumer behavior analysis. Based on the analysis of three classical theoretical models, this paper constructs a structural equation model which accords with the research goal of this paper. Through the use of questionnaire survey method, which acting as the specific research method, to obtain relevant research data. Reasonable data are analyzed and modeled through SPSS and AMOS. After passing relevant tests, multi-dimensional analysis, accurate prediction, and one-to-one recommendation are proved to be necessary ways for educational institutions to obtain profits and improve consumer satisfaction. LSTM-based consumer behaviour analysis is to learn features offline, build models under the background of big data, and analyze and predict consumption behaviour online to achieve recommendation prediction.

To be sure, the research has only just begun because of the limited experimental conditions for scientific research. The research on consumer behaviour analysis based on LSTM is not deep enough, and there is still a lot of work to be carried out in the future. Because the basic characteristics of the surveyed persons are less, and the sample size is limited. Although cluster analysis is tried, the effect is not good. In fact, the clustering effect can be improved by expanding the features and sample size. And the clustering using distributed big data is consistent with the results obtained by one-time clustering, so that the characteristics of the surveyed can be more clearly portrayed.

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