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Evaluation of Sports Ads Value Based on Consumer Psychology

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Abstract: The effective dissemination of ads information can stimulate consumers' desire to purchase sports products/services. In return, the purchases by consumers reflect the effectiveness of media dissemination of sports ads. Currently, there is not yet an index system or evaluation model for accurate evaluation of sports ads value. The relevant research of ads value is detached from consumers' willingness to buy and purchases. Therefore, this paper presents a novel sports ads value evaluation method based on consumer psychology. Firstly, a reasonable evaluation index system (EIS) was established, and the index data were processed by principal component analysis (PCA) based on consumer psychology. Next, Schwartz-Moon model was extended into a sports ads value evaluation model in the light of consumer psychology and applied to evaluate sports ads value through numerical simulation. Our model and EIS were proved effective through experiments.

Keywords: consumer psychology; sports ads; value evaluation

Introduction

The national fitness campaign has created an unprecedented opportunity for the development of the sports industry (Abbasi et al., 2021; Mekawie and Hany, 2019). Currently, China's sports market is dominated by the subjective emotions of consumers and can be considered as a buyer's market (Chu et al. 2020; Dehghani and Tumer, 2015; Hsiao and Chang, 2014). In this era of emotional consumption, the effective dissemination of sports ads information can stimulate consumers' desire to purchase sports products/services. From ads media, consumers can perceive the products/services of sports enterprises. The perception directly affects their willingness to buy. In return, the purchases by consumers reflect the effectiveness of media dissemination of sports ads (Fatehkia et al., 2020; Samuel et al., 2021).

The number of sports has increased in recent years including tennis, hockey, kabaddi, football, wrestling and badminton that contribute to multi-billions in the Indian sports market and increased trend among public has attracted large number of fans, sponsors and media. The studies have been reported that sports market has increased specifically in India about 14% and further rise is expected in near future. The sponsors have increased their investments in sports industry and that activity has increased the financial boost in country (Trivedi, 2020). The research study has been conducted to investigate the purchase intention towards sports influenced by corporate image on brand love, brand love mediates the relationship between corporate image and purchase intention. The study also reported moderating effect of sports involvement between brand love and purchase intention. The results depicted that purchase intention is influenced by brand love and corporate image, as mediating role of brand love and moderating role of sports involvement was reported significant (Trivedi, 2020). The purchase intention has been investigated in previous literature as it has grabbed attention of various research scholars due to its crucial importance. The study investigated the influence of team identification on Ad content value and purchase intention, the study addressed the moderating role of sports influencer credibility between Ad content value and purchase intention, similarly the mediating role of Ad content value was investigated between the relationship of team identification and purchase intention. The purchase intention was positively significant and influenced by team identification and Ad content value. The study reported significant moderating role of sports influencer credibility and significant mediation role of Ad content value between team identification and purchase intention (J. K. Lee, 2021). The literature established that advertisement facilitates the purchase intentions and considered as one of the major goals to attract the customers. The research studies have addressed the effectiveness of advertisement that induces the purchase intention towards the specific goods, the advertisement also ensure the purchase behavior. The prior research literature found the support for attitude towards advertising and purchase intention. The research studies have examined that involvement towards various products, corporation and advertisement influence the attitude of consumers towards advertising and brand that also influence the purchase intention and positive relationship has been reported between attitude towards advertisement and purchase intention (Kim, Haley, & Koo, 2009). The positive association between attitude towards advertising and purchase intention has been established in the study of investigating the effects of corporate and celebrity credibility on consumer reaction to advertising. The study reported that attitude towards advertising found to be key variable that affect and influence the purchase intention. The study reported that significant relationship between informativeness and entertainment that influence the attitude towards the advertising, further the attitude towards the brand influenced by attitude towards advertisement. Most importantly, the purchase intention was influenced by attitude towards advertisement and

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attitude towards brand about golf sport industry and equipment (Y.-g. Lee, Byon, Ammon, & Park, 2016). Another study incorporated the antecedents of purchase intention towards sports goods and equipment, the study highlighted that informativeness, interactivity, entertainment, credibility, irritation and accessibility. The study reported that credibility, interactivity and irritation has positive significant relationship towards purchase intention of customers of sports industry (Choudhary, Dubey, & Baghel, 2018).

The prior study investigated the purchase intention and electronic word-of-mouth (eWOM) influenced by consumers' corporate social responsibility (CSR) in the presence of social media and responses to brands. The identification of brands and brand attitude expected to be influential towards purchase intention and word-of-mouth. The empirical relationship between CSR in social media, the brand identification and brand attitude that influence the purchase intention and electronic word-of-mouth. The study reported significant relationship that consumers' CSR activities through social media that impact the purchase intention and word-of-mouth (Chu & Chen, 2019). Another study conducted to determine the purchase intention influenced by celebrity-product congruence, attitude towards brand, celebrity awareness, attitude towards advertisement and consumer involvement. The study reported the results that celebrity attractiveness, consumers' attitude towards advertisement and attitude towards brand significantly influence the purchase intention (Arora, Prashar, Parsad, & Tata, 2019).

The study has been addressed the role of customer satisfaction, perceived value, corporate image and service quality in sports industry while expressed the dimensions of service quality. The current study incorporated the perceived value to explain the purchase intention in sports industry of China. The perceived value referred as the consumer's overall assessment of the utility of product of services based on perception that what is given against received. The service quality has been reported as related to perceived value and customer satisfaction. It also has been point outed that quality of services is one of the most important factor that influence the perceived value that is considered as key determinant of customer satisfaction (Lovelock, Wirtz, Keh, & Lu, 2005; Tarn, 1999). The literature has confirmed the existence of relationship between perceived value, satisfaction and quality in education industry, the literature has expressed the phenomenon of perceived value and related to the older concept of customer behavior (Gallarza & Saura, 2006; Wu, 2014), however the studies have indicated that there is scarcity of literature on perceived value specifically in sports industry (Wu, 2014).

The number of sports events has increased in China that attract large number of consumers and marketing is an integral part of these efforts to attract the customers. The world largest population China the fastest growing economy and has potential to increase the customer base in sports industry. On the other hand, it has been stated that decrease in spectator attendance occurred as major challenge in Chinese sports event organizers. The Wuhan Tennis Open, the stadium was pictured in 2018 that showed the less number of attendees during such an higher caliber international sports event (Qian & Zhang, 2019; Tian et al., 2021). The problem has been highlighted that growing number of sports events without spectators wouldn't grow the size of sports industry in China. The challenges have to be addressed in literature to identify the possible solutions and to gain the customer base in sports industry of China. It is crucial for marketing department that promote the sports events to understand the factors that influence the decision of consumers towards sports (Johnson, Chou, Mastromartino, & Zhang, 2021). The prior studies have explained the phenomenon of perceived value to assess the influence on consumption towards the sports equipment and sports events. The results reported that dimensions of service quality including game operation, stadium quality, game accessibility and store operation to be influential towards perceived value that further predict the consumptions, the results depicted that store operation and stadium quality has no effect on perceive value that further influence the consumption, however the game operation and accessibility influence the relationship (Tian et al., 2021). Another study focused on the tourism sports and explained the phenomenon of satisfaction and revisit intention influenced by perceived image, perceived value and destination image. The study reported that destination image, perceived value, and perceived quality influence the satisfaction that further predict and influence significantly the revisit intention of individuals at sports tourism (Allameh, Pool, Jaberi, Salehzadeh, & Asadi, 2015).

In recent years, great changes have taken place in the structure of the sports industry and the consumer views of sports consumption. Against this backdrop, it is meaningful to explore the influence of sports ads on consumption willingness and behaviors (Budiharja et al., 2020; Chen and Chao, 2014; Kim et al., 2019; Lin and Bautista, 2018; Wibowo et al., 2020). De Boer et al. (2010) studied how TV sports ads affect sports consumption, explored the relationship between ads, willingness to buy, and consumption behavior through variance analysis and regression analysis, and clarified the value of intermediary mechanism of sports ads. With the rapid development of Internet technology, the dissemination form and path of ads are increasingly diverse (Enwereuzor, 2017; Johnson et al., 2018). Ryu and Park (2020) evaluated the content value, media value, and user value of new media ads from the dimensions of content generation and push, social platform and media attributes, as well as user portraits and precision marketing under algorithm logic. Relying on online social platforms, ads can propagate quickly through social networks, and achieve obvious communication advantages and advertising effects (Liang, 2020; Meng, 2017; Shih and Yang, 2017; Sizov and Pille, 2016). Lin et al. (2016) renovated the business model and marketing measures of WeChat, a new media with high social and

communication values, and analyzed the WeChat ads value from three aspects, namely, main profit elements, profit structures, and profit models.

The existing evaluation systems of ads value lack scientific basis and decision-making information (Ferraresi, 2019; Kim et al., 2019; Rallapalli et al., 2014; Vitorino, 2014). Assuming that dissemination creates value, Wu and Hsiao (2017) constructed an evaluation system for media ads value, which contains consumption attention, consumption cognition, consumption persuasion, and consumption decision-making power. Togookhuu et al. (2017) claimed that consumer perceived value drives consumption behaviors and proposed a strategy to obtain the accurate attitude of consumers to ads: exploring how the social attributes of consumers regulate the relationship between perceived value and attitude to ads, after comprehensive consideration of the positive and negative effects of consumer perceived value. Shouman (2020) highlighted the action mechanism of the interaction between seller and consumer, and that between consumers on the perception of product/service values and the willingness to buy. Warren-Myers et al. (2020) renovated the content delivery form of interactive ads in public social networks, expanded the application scenarios and social attributes of these ads, and discussed the way to ensure the consistency of consumer perception and ads value, on the application level of ads marketing.

The purchase intention of customers has been explained among under-graduate students involved in online platforms for purchasing, the study incorporated the role of brand equity and brand image between social media (FACEBOOK) advertisement and purchase intention. The study depicted that social media applications (FACEBOOK) advertising influence the brand image and brand equity and both contributed towards the increase in purchase intention of customers (Dehghani & Tumer, 2015). Another study conducted in China among internet market users to assess their continued intention towards mobile phone purchases, the study incorporated the role of trust, flow and satisfaction to explain the purchase intention, further the study investigated the influence of system quality, information quality, service quality and privacy and security concerns. The results depicted that information quality, privacy and security concern influence the trust, the system quality influence the satisfaction. The higher the trust, the higher the satisfaction and further it leads towards the increased intention towards mobile purchase (Gao, Waechter, & Bai, 2015).

There is not yet an accurate evaluation index system (EIS) or evaluation model. The relevant research of ads value is detached from consumers' willingness to buy and purchases. Therefore, this paper presents a novel sports ads value evaluation method based on consumer psychology. Specifically, Section 2 builds up a reasonable EIS, and processes the index data through principal component analysis (PCA) based on consumer psychology. Based on Schwartz-Moon model, Section 3 develops a sports ads value evaluation model in the light of consumer psychology and applies the model to evaluate sports ads value through numerical simulation. Our model and EIS were proved effective through experiments.

The current research effort is unique in number of aspects and contribute to the body of knowledge to explain the willingness to purchase among sports industry. The advertisement and promotion play crucially important role for the sales of sports products/services. The key to advertising promotion is to enhance ads value. This current research paper provides a theoretical guide for the effective advertising of sports products/services. The advertising value comes from consumers. The effectiveness of an ad depends on the number of consumers it can draw. Therefore, this research has strong practical significance. Further, this paper tries to explore the ads value of sports products/services enterprises from the perspective of consumers and enrich the marketing theory of sports products/services. Moreover, this paper attempts to establish a consumer oriented EIS and evaluation method for sports ads value and update the theory on ads value evaluation. The research values of this paper lie in breaking through the limitations of index samples, EIS, and evaluation method.

Theoretical Support

The current study intends to determine the willingness to buy towards sports equipment influenced by perceived value based on cost value, functional value and quality value. The relationship in proposed framework is underpinned by the theory of reasoned action, that posits that behavioral intentions are an important antecedent of actual behavior (Fishbein, Jaccard, Davidson, Ajzen, & Loken, 1980). The actual acceptance of the product or service in the market is determined or measured by the observation of behavioral intentions as depicted by the theory. The consumer's judgement has been expressed under the umbrella of purchase intention, if the consumers purchase the advertised brand in near future (MacKenzie & Lutz, 1989). The prior studies have established the relationship that intentions are antecedents of actual behavior (Sheeran & Orbell, 1998; Trivedi, 2020). The previous studies have argued that sports event sponsorship and purchase intention are related and has significant relationship, the purchase intention considered as one of the most useful indicators that impact the sponsorship (Madrigal, 2000). The recent studies have established the link that brand love has significant positive relationship with purchase intention as brand love influence the purchase intentions (Fetscherin, 2014; Kudeshia, Sikdar, & Mittal, 2016).

Similarly, the current framework is underpinned by the theory of reasoned action that willingness to buy is determined by perceived value, the function value, cost value and quality value, as these factors influence the purchase intention. So therefore, the theory of reasoned action provides the theoretical support for framework to investigate the relationships.

EIS and PCA

EIS

High-value sports ads help to build good sports brand and improve sports service image. The nonfunctional factors of sports ads serving have a significant direct promoting effect on the perception, willingness to buy, and consumption behaviors of potential consumers. To explore the relationship between the value of sports ads served by sports products/services enterprises and the psychology of potential consumers watching these ads, this paper firstly constructs a reasonable and complete EIS for sports ads value based on consumer psychology and processes the index data through PCA. The current study argues that the EIS construction adheres to the following principle: building a typical, dynamic, concise, scientific, comparable, operation, quantifiable, and comprehensive. Then, a sports ads value evaluation framework was established based on Schwartz-Moon model and adopted to accurately evaluate the sports ads value based on consumer psychology. The proposed hierarchical EIS contains four primary indices: brand image, consumer perceived value, ads attribute, and willingness to buy. All the index scores were given by experts in relevant fields through objective evaluation and quantification. Under the primary index of brand image, there are three secondary indices: corporate image AV_{11}, sports products/services image AV_{12}, and ads image AV_{13}. Corporate image AV_{11} consists of five tertiary indices: corporate scale AV_{111}, corporate history AV_{112}, market share AV_{113}, salesman image AV_{114}, and brand style AV_{115}. Ad's image AV_{13} consists of three tertiary indices: ads smoothness AV_{131}, ads novelty AV_{132}, and spokesman image AV_{133}.

The established EIS was proved reasonable and scientific by weighing against the purpose of the sports ads value analysis, and the principles of EIS construction. Besides, the correlations between the selected indices were tested to clarify the connotations and calculation methods of indices and determine the logic relationship between indices.

The confirmatory factor analysis (CFA) map of brand image is shown in Figure 1.

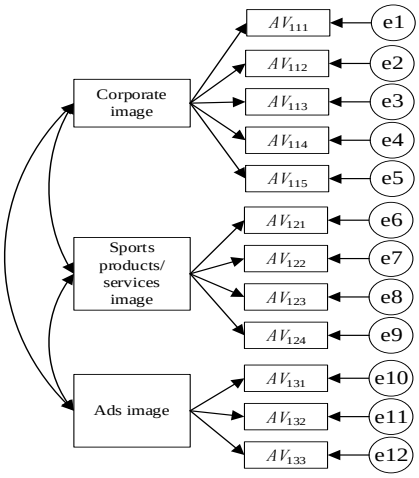

Figure 1. CFA map of brand image

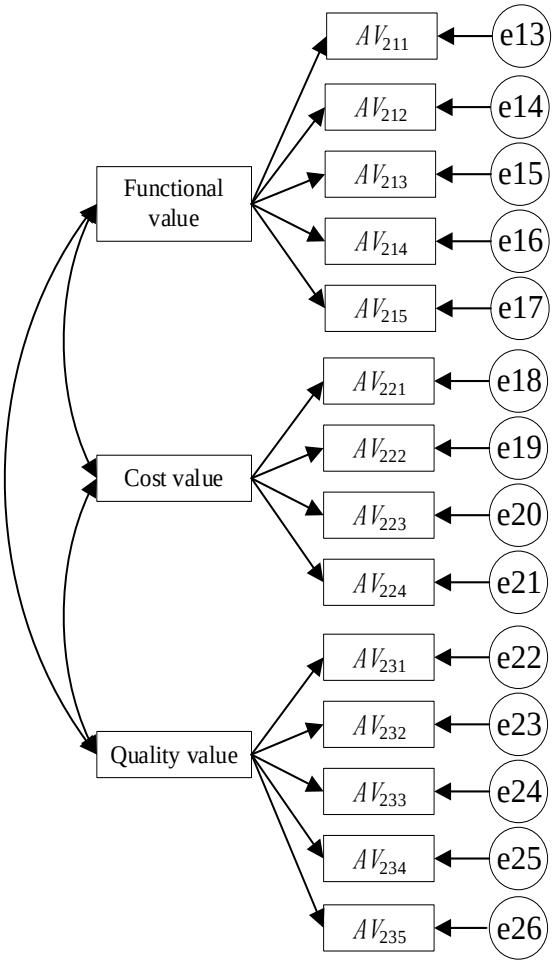

Figure 2. CFA map of consumer perceived value

Under the primary index of consumer perceived value, there are five secondary indices: functional value AV_{21}, cost value AV_{22}, and quality value AV_{23}. Functional value AV_{21} consists of five tertiary indices: physical exercise function AV_{211}, physical exercise auxiliary function AV_{212}, sports facility service AV_{213}, sports venue service AV_{214}, and sports health function AV_{215}. Cost value AV_{22} consists of four tertiary indices: price AV_{221}, number of auxiliary products AV_{222}, additional service AV_{223}, and after service AV_{224}. Quality value AV_{23} consists of five tertiary indices: durability AV_{231}, convenience AV_{232}, reliability AV_{233}, precision AV_{234}, and safety AV_{235}. The CFA map of consumer perceived value is shown in Figure 2.

Under the primary index of ads attribute, there are four secondary indices: advertising environment AV_{31}, media attribute AV_{32}, ads visibility AV_{33}, and ads cost AV_{34}. Advertising environment AV_{31} consists of four secondary indices: space size AV_{311}, crowd density AV_{312}, ads density AV_{313}, and peripheral interference AV_{314}. Media attribute AV_{32} consists of three secondary indices: web position exclusivity AV_{321}, ads form AV_{322}, and exposure AV_{323}. Ads visibility AV_{33} consists of the following secondary indices: effective visible distance AV_{331}, unavoidability of visibility AV_{332}, travel time in effective visible distance AV_{333}, visible

impression AV_{334}, visible frequency AV_{335}, and visible height AV_{336}. Ad's cost AV_{34} consists of two tertiary indices: media cost AV_{341}, and advertising cost AV_{342}. The CFA map of adds attribute is shown in Figure 3.

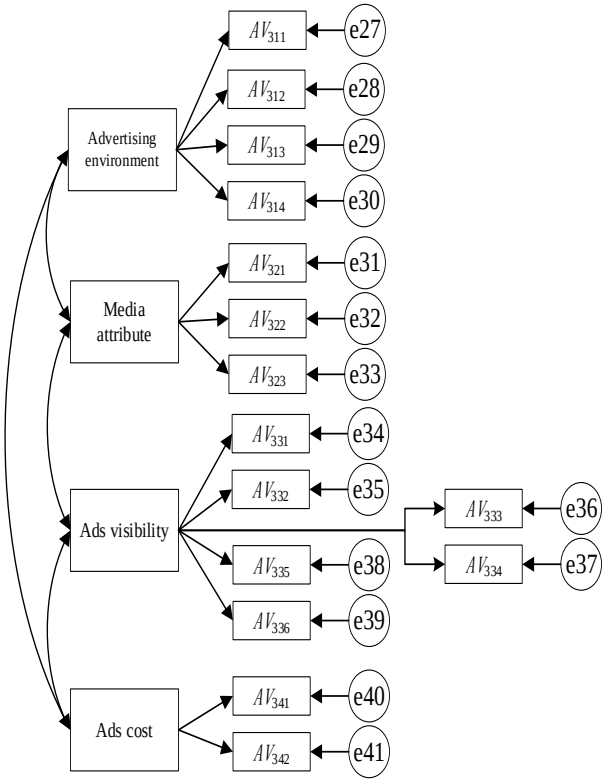

Figure 3. CFA map of ads attribute

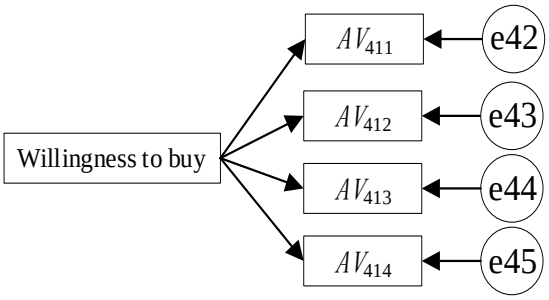

Figure 4. CFA map of willingness to buy

Under the primary index of willingness to buy AV_{41}, there are four secondary indices: first choice AV_{411}, repurchase willingness AV_{412}, after-use recommendation AV_{413}, and after-use positive review AV_{414}. The CFA map of willingness to buy is shown in Figure 4.

PCA

This paper processes the data on the indices of sports ads value based on consumer psychology. The basic idea is to obtain several loosely correlated indices that can characterize the largest portion of sports ads value through linear transform of matrices.

Firstly, the original index data are converted into an original matrix A:

$$A^* = \begin{bmatrix} a_{11}^* & a_{12}^* & \cdots & a_{1m}^* \\ a_{21}^* & a_{22}^* & \cdots & a_{2m}^* \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1}^* & a_{m2}^* & \cdots & a_{mm}^* \end{bmatrix} \quad (1)$$

Then, A is normalized into a correlation coefficient matrix E:

$$E = \begin{bmatrix} e_{11} & e_{12} & e_{13} & \cdots & e_{1m} \\ e_{21} & e_{22} & e_{23} & \cdots & e_{2m} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ e_{m1} & e_{m2} & e_{m3} & \cdots & e_{mm} \end{bmatrix} \quad (2)$$

If all or most of the correlation coefficients in E are greater than 0.3, the matrix can be dimensionally reduced through PCA. Since E is symmetric, the correlation coefficients in the matrix can be described by:

$$e_{ij} = \frac{1}{n-1}\sum_{i=1}^{n}\left(a_{ii}a_{jj}\right)^2 \quad (3)$$

To extract the right principal components from the indices, the characteristic roots μ_l(l=0,1, 2,…m) of E are solved, and sorted in descending order as $\mu_1 \geq \mu_2 \geq \ldots \geq \mu_m$. The resulting eigenvectors are denoted as B_1, B_2,…,B_m, and the l-th eigenvector as $B_l=(b_{1l}, b_{2l}, \ldots, b_{ml})^T$(l=0, 1, 2, …m). Then, the variance explained by the principal component G_k of the l-th index can be calculated by:

$$\sigma_l = \frac{\mu_l}{\sum_{l=1}^{m}\mu_l} \quad (4)$$

The total variance explained by the principal components G_1, G_2,…,G_l of l indices can be calculated by:

$$\sum_{i=1}^{l}\sigma_i = \frac{\sum_{i=1}^{l}\mu_i}{\sum_{i=1}^{m}\mu_i} \quad (5)$$

Normally, the top o principal components must explain more than 90% of the variance:

$$\sum_{i=1}^{o}\sigma_i \geq 90\% \quad (6)$$

The eligible principal components G_1, G_2,…,G_o can be expressed as:

$$G_1 = (A_{i1}, A_{i2}, \ldots, A_{im}) \cdot B_1 = \sum_{l=1}^{m} a_{il}\, b_{l1} \quad (7)$$

$$G_o = (A_{i1}, A_{i2}, \ldots, A_{im}) \cdot B_o = \sum_{i=1}^{m} a_{il}\, b_{lo} \quad (8)$$

Then, the principal component scores of all indices are summarized, and the indices are ranked in descending order of the scores. Taking variance explained as weight, the principal components of the indices are subjected to weighted superimposition to obtain the corresponding composite score of sports ads value:

$$G_i^{'} = \sum_{l=1}^{o}\sigma_l\, G_{il} \quad (9)$$

The composite score is then normalized. The weight of each principal component is the ratio of the score of each index to the total composite score:

$$w_i = \frac{G_i^{'}}{\sum_{i=1}^{n} G_i^{'}} \quad (10)$$

Schwartz-Moon Model-Based Evaluation of Sports Ads Value

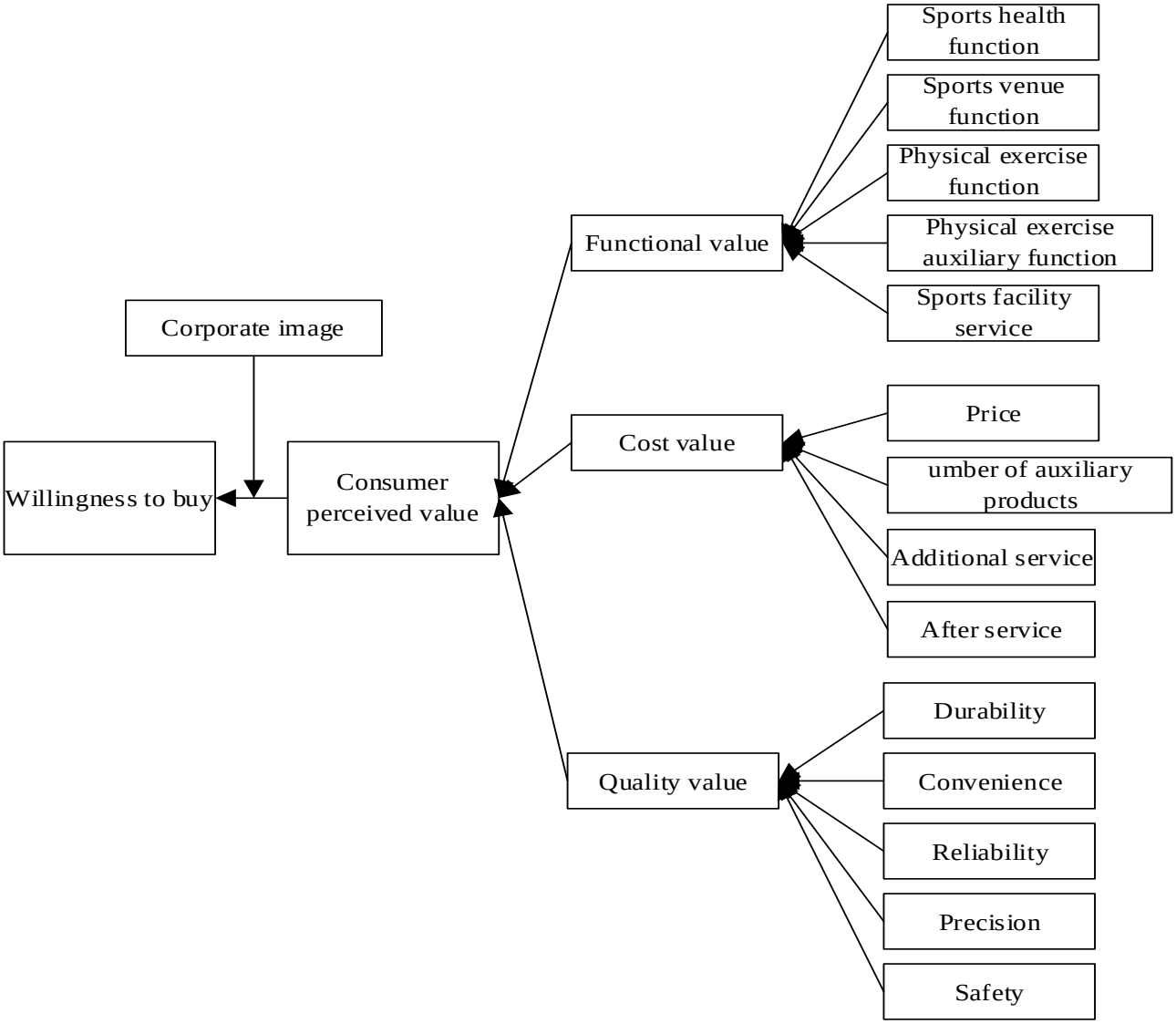

Figure 5. Evaluation model for the influence of consumer perceived value on sports ads value

Schwartz-Moon model is often used to simulate all the possibilities of future cash flows, quantify the business value of industrial chains, enterprises, and commodities, and link this value with future development. Figure 5 shows the evaluation model for the influence of consumer perceived value on sports ads value. This paper employs the Schwartz-Moon model to make further evaluation based on the model in Figure 5 through numerical simulation. Four assumptions were put forward: (1) The instantaneous fluctuations in sports ads income based on consumer psychology are geometric Brownian motions; (2) The change of income growth rate induced by sports ads is a stochastic mean reversion process; (3) All indices in the model are independent of each other; (4) Every sports products/services enterprise transforms all the after-tax net profit increment brought by sports ads into the available cash to implement all business activities.

For a given period h, the volatilities of expected income growth rate and income brought by sports ads can be denoted as ε(h) and λ(h), respectively, and the means of the two parameters as ε^* and λ^*, respectively. The income change dc_1 caused by factors other than sports ads obeys normal distribution. Let IN(h) be the income of sports products/services enterprise in period h. According to the previous assumptions, we have:

$$\frac{dIN(h)}{IN(h)} = \varepsilon(h)dh + \lambda(h)dc_1 \quad (11)$$

For the sports products/services enterprise, the income grows rapidly right after advertising. But the growth rate will gradually converge to the long-term average level. Therefore, the mean reversion coefficient ζ was defined to characterize the speed of the income growth rate induced by sports ads to return to the long-term average level. Half

of the regression time is denoted as Ln2/ζ. The volatilities of income growth rate induced by sports ads and other factors are denoted as θ(h) and dc_2, respectively, in period h. According to the previous assumptions, we have:

$$d\varepsilon(h) = \zeta\big(\varepsilon^* - \varepsilon(h)\big)d(h) + \theta(h)dc_2 \quad (12)$$

Let ζ_1 be the speed for λ(h) to converge to λ^*. According to the previous assumptions, we have:

$$d\lambda(h) = \zeta_1\big(\lambda^* - \lambda(h)\big)d(h) \quad (13)$$

Let ζ_2 be the speed for θ(h) to converge to 0. According to the previous assumptions, we have:

$$d\theta(h) = -\zeta_2\theta(h)d(h) \quad (14)$$

Let β(h) and CO be the sports ads cost coefficient and fixed coefficient, respectively. In period h, the total ads cost containing CO and variable cost can be described as:

$$C_T(h) = \beta(h)IN(h) + CO \quad (15)$$

Formula 15 shows the variable cost is positively proportional to IN(h). The ads cost rate of the sports products/services enterprise would change with the competitors, market share, and the innovation of production techniques and service modes. During the change, β(h) will gradually converge to the long-term average level. Let ζ_3 be the convergence speed; dz_3dc_3 be the cost change rate induced by other factors; ψ(h) be the cost change rate induced by sports ads. According to the previous assumptions, we have:

$$d\beta(h) = \zeta_3\big(\beta^* - \beta(h)\big)d(h) + \zeta(h)dc_3 \quad (16)$$

Let ζ_4 be the speed for ψ(h) to converge to the mean cost change rate. According to the previous assumptions, we have:

$$d\psi(h) = \zeta_4\big(\psi^* - \psi(h)\big)d(h) \quad (17)$$

Meanwhile, the cost change rate dc_3 induced by other factors has the following relationship with dc_1 and dc_2:

$$dc_1dc_3 = k_{13}dh \quad (18)$$

$$dc_2dc_3 = k_{23}dh \quad (19)$$

If both k_{13} and k_{23} are zero, then income growth c_3 is independent of c_1 and c_2.

Let η_T and TAX(h) be the tax rate and tax amount of the enterprise, respectively. Based on IN(h) and C_T(h), the net profit of the enterprise after period h can be calculated by:

$$NE(h) = [IN(h) - C_T(h) - TAX(h)](1 - \eta_T) \quad (20)$$

In period h, the ads investment FA(h) of sports products/services enterprise depends on the total capital expenditure CE(h) and tax amount TAX(h) of the enterprise. Suppose TAX(h) is DR times of FA(h), and CE(h) is CR times of IN(h). Then, FA(h) satisfies:

$$dFA(h) = [CE(h) - TAX(h)]dh \quad (21)$$

TAX(h) satisfies:

$$TAX(h) = DR * FA(h) \quad (22)$$

CE(h) satisfies:

$$CE(h) = CR * IN(h) \quad (23)$$

Our model assumes that the sports products/services enterprise only pursues risk-free income through ads serving. Let α be the rate of return of the ads. Then, the available cash AC(h) for the enterprise to serve ads in period h can be estimated by:

$$dAC(h) = [\alpha AC(h) - NE(h) + TAX(h) - CE(h)]dh \quad (24)$$

If the ad serving does not bring the ideal income, the enterprise will suffer a loss in ads investment. In this case, the model parameters containing ads risk factors should be adjusted. Let RP(h) be the loss of ads investment; α_{SC} be the total rate of return of market portfolio; α_{WR} be the risk-free rate of return of market portfolio; γ_E be the correlation coefficient between the income growth rate induced by sports ads and the rate of return indicated by the sports products/services market index. Then, the model can be updated after the parameters containing ads risk factors are adjusted. Specifically, income IN(h) can be expressed as:

$$\frac{dIN(h)}{IN(h)} = [\varepsilon(h) - RP(h)]dh + \lambda(h)dc_1 \quad (25)$$

The loss of ads investment RP(h) can be estimated by:

$$\lambda(t) = \beta_R\big(r_m - r_f\big) \quad (26)$$

$$RP(h) = \gamma_E(\alpha_{SC} - \alpha_{WR}) \quad (27)$$

Under the neutral measure of loss risk (NM_{LR}) for the loss of ads investment, the ads value CW in period h can be calculated from the risk-free rate of return of the ads and the net income brought by the ads. Let exp(sh) be the continuous earnings discount factor, a mirror of the low loss risk of ads investment. Then, the ads value in any period h is equivalent to the arithmetic sum of the cumulative advertising profit and the ads investment cost in the prediction period:

$$CW = NM_{LR}\{A(h) + N * [IN(h) - C_T(h)]\}\exp(sh) \quad (28)$$

Let Δh be the time increment; ε(h) and ε(h+Δh) be the income growth rates induced by ads investment in period h and period h+Δh, respectively; κ_1, κ_2, and κ_3 obey standard normal distribution. Based on the seasonal/annual financial data collected from sports products/services enterprises, the continuous time model in the above analysis can be discretized. Then, income can be discretized as:

$$IN(h + \Delta h) = IN(h)\,exp\left\{\left[\varepsilon(h) - RP^*\lambda(h) - \frac{\lambda(h)^2}{2}\right]\Delta h + \lambda(h)\sqrt{\Delta h}\kappa_1\right\} \quad (29)$$

Let IN(h) and IN(h+Δh) be the ads-induced incomes in period h and period h+Δh, respectively. Then, income growth rate can be discretized as:

$$\varepsilon(h + \Delta h) = exp(-\zeta\Delta h)\,\varepsilon(h) + (1 - exp(-\zeta\Delta h))\varepsilon^* + \sqrt{\frac{1 - exp(-2\zeta\Delta h)}{2\zeta}}\theta(h)\kappa_2 \quad (30)$$

Let β(h) and β(h+Δh) be the cost coefficients of ads investment in in period h and period h+Δh, respectively. Then, the cost coefficients can be discretized as:

$$\beta(h + \Delta h) = exp(-\zeta\Delta h)\,\beta(h) + (1 - exp(-\zeta\Delta h))\overline{\beta} + \sqrt{\frac{1 - exp(-2\zeta\Delta h)}{2\zeta}}\psi(h)\kappa_3 \quad (31)$$

Let λ_0 and λ(h) be the standard deviations of the income induced by ads investment at the initial moment and period h, respectively. Then, we have:

$$\lambda(h) = \lambda_0 \, exp(-\zeta \Delta h) + \lambda^*(1 - exp(-\zeta \Delta h)) \quad (32)$$

Let θ_0 and $\theta(h)$ be the standard deviations of the income growth rate induced by ads investment at the initial moment and period h, respectively. Then, we have:

$$\theta(h) = \theta_0 \, exp(-\zeta \Delta h) \quad (33)$$

Let $\psi(h)$ and $\psi(h+\Delta h)$ be the cost volatilities caused by ads investment in period h and period h+Δh, respectively. Then, we have:

$$\psi(h) = \psi_0 \, exp(-\zeta \Delta h) + \psi^*(1 - exp(-\zeta \Delta h)) \quad (34)$$

After obtaining the initial values, our model was subjected to repeated Monte-Carlo simulations on MATLAB to obtain a result comparable to the expected value of ads investment.

Let V =exp(A) be the random variable A in sports ads value estimation based on consumer psychology. Suppose m independent random variables $A_1A_2A_3....A_m$ obeys the probability distribution of the random variable A are obtained through m Monte-Carlo simulations. The mean A^* is basically equal to V. Then, the expectation of A^* can be calculated by:

$$A^* = \frac{1}{m}\sum_{i=1}^{m} A_i \quad (35)$$

The variance of A^* can be calculated by:

$$E(A) = \frac{1}{m}\sum_{i=1}^{m} A_i = V \quad (36)$$

$$Var(A^*) = Var\left(\frac{1}{m}\sum_{i=1}^{m} A_i\right) = \frac{1}{m^2}\left(\sum_{i=1}^{m} A_i\right) = \frac{1}{m^2}\sum_{i=1}^{m} Var(A_i) = \frac{\sigma^2}{m} \quad (37)$$

Experiments and Results Analysis

Table 1

Correlation analysis of primary indices

Pearson correlation	AV_1	AV_2	AV_3	AV_4
AV_1	1			
AV_2	0.479 0.001	1		
AV_3	0.526 0.001	0.638 0.001	1	
AV_4	0.309 0.001	0.235 0.001	0.425 0.001	1

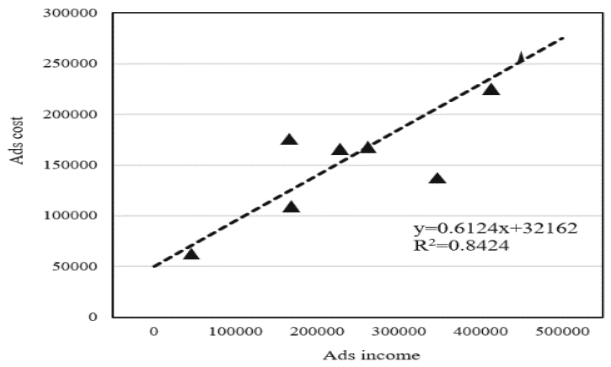

Figure 6. Linear regression results on ads income-ads cost curve

To measure the closeness between any indices in the proposed EIS for sports ads value based on consumer psychology, this paper carries out a Pearson correlation analysis, which can test whether variables are linearly correlated. The principle is that: if the correlation coefficient is greater than 0.7, then two indices must be colinear. Table 1 presents the correlation analysis results on the four primary indices: brand image, consumer perceived value, ads attribute, and willingness to buy. Since all p values were smaller than 0.01, the indices do not have obvious correlations, and are eligible for subsequent evaluation.

Based on the expenditure, income, and profit of a sports product enterprise in 2018-2020, the authors calculated the variable cost of ads investment. Figure 6 presents the linear regression results on the relationship between the variable cost and the income brought by the ads. The variable cost is the slope of the straight line in the figure, while the fixed cost is the intercept (32,162) in the figure.

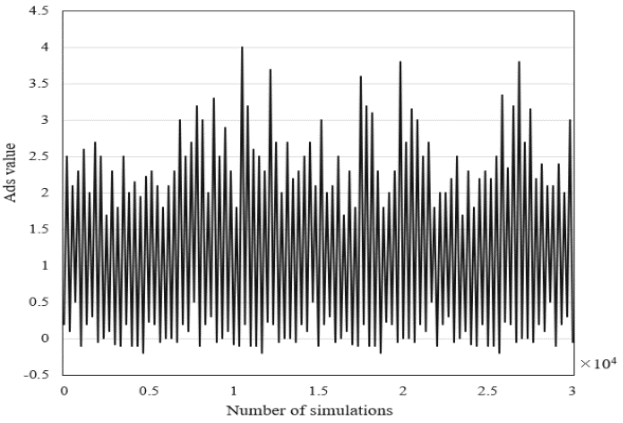

Figure 7. Distribution of sports ads value

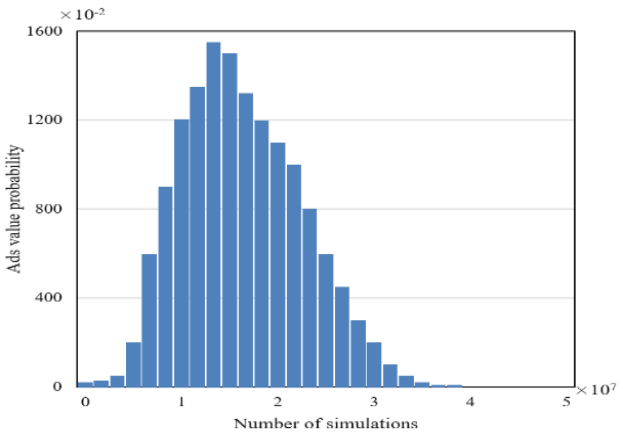

Figure 8. Distribution of ads value probability

The experimental data was collected through objective surveys and operating data of typical sports products/services enterprises in the region as required in the current study. Based on MATLAB, Schwartz-Moon model was coupled with Monte-Carlo simulation to evaluate the sports ads value based on consumer psychology. Through 25,000 repeated simulations, the distribution of the ads value of the enterprise and the probability distribution of ads value were obtained. As shown in Figures 7 and 8, the ads value amounted to 352,100 yuan.

Table 2

Relationship between initial income growth rate and sports ads value

Income growth rate	Ad's value	Value change rate
17.25%	332,500	-8.3251%
21.35%	356,700	-3.1254$
23.49%	361,200	0
24.85%	372,100	3.5812%
27.37%	395,200	7.6803%
29.98%	421,200	9.8950%

Table 2 shows the relationship between the initial income growth rate and sports ads value. When the initial income increased by 13%, the ads value changed by less than 6%. Therefore, the initial income change rate has a limited effect on the ads value. Besides, the ads value increased at a growing speed with the increase of the initial income brought by the ads, and the value change rate gradually stabilized. Therefore, sports ads value has an obvious positive correlation with the initial income growth rate.

Table 3

Relationship between initial income volatility and sports ads value

Income volatility	Ad's value	Value change rate
5.21%	331,050	-0.635%
6.13%	357,400	-0.120$
6.97%	378,900	0
7.49%	351,500	-0.302%
8.35%	365,800	0.2720%
9.41%	371,200	0.3125%

Table 3 shows the relationship between the initial income volatility and sports ads value. When the initial income fluctuated by 5%, the ads value changed by less than 1%. The change amplitude was much smaller than that under the influence of initial income growth rate. Moreover, the ads value change rate did not multiply, for every 1% change in initial income volatility. Hence, there is no obvious law in the influence of initial income volatility on ads value.

Table 4

Relationship between long-term income volatility and sports ads value

Income volatility	Ad's value	Value change rate
8.21%	334,500	-0.241%
9.37%	341,500	-0.112%
10.56%	350,400	0
11.92%	382,300	0.031%
12.78%	397,400	0.262%
13.59%	425,300	0.317%

Table 4 shows the relationship between the long-term income volatility and sports ads value. When the long-term income fluctuated by 5%, the ads value changed by far less than 1%. This confirms that long-term income volatility has a much smaller impact on sports ad value than the previous two parameters. Although sports ads value increased with the long-term income growth rate, the positive correlation between the two factors is not significant.

Table 5 shows the relationship between the long-term cost volatility and sports ads value. When the long-term cost volatility varied by 10%, the sports ads value changed by less than 0.2%. Hence, the long-term cost volatility has a limited impact on the sports ads value. The impact is greater than the effect of long-term income volatility, but smaller than the effect of initial income growth rate.

Table 5

Relationship between long-term cost volatility and sports ads value

Initial cost volatility	Ad's value	Value change rate
0.142	3,625,000	-0.325%
0.168	3,762,100	-0.145%
0.195	3,852,200	0
0.205	3,953,500	0.159%
0.216	4,196,000	0.356%
0.235	4,250,200	0.395%

Figure 6 shows the relationship between mean regression coefficient and sports ads value. When the mean regression coefficient varied by 10%, the sports ads value changed by less than 3%, indicating that the mean regression coefficient has a limited impact on sports ads value. Overall, the impact is greater than the effect of initial cost volatility, and smaller than the effect of income growth rate. It can also be inferred that the mean regression coefficient has an apparent negative correlation with sports ads value. That is, sports ads value decreases with the growth of the mean regression coefficient. A low mean regression coefficient means a high and volatile sports ads value.

Table 6

Relationship between mean regression coefficient and sports ads value

Mean regression coefficient	Ad's value	Value change rate
0.4352	3,906,000	5.301%
0.4821	3,702,500	2.672%
0.5535	3,703,000	0
0.6230	3,571,000	-2.158%
0.6520	3,496,200	-3.537%
0.6953	3,315,000	-4.368%

Conclusions

This paper presents an evaluation method for sports ads value based on consumer psychology. Firstly, a reasonable EIS was

constructed for sports ads value in the context of consumer psychology, and the index data were processed through PCA. With the aid of numerical simulation, our evaluation model for sports ads value based on consumer psychology was improved by Schwarz-Moon model. During the experiments, Pearson correlation analysis was performed to measure the closeness between any indices, which confirms that the indices are not obviously correlated. Then, a simple regression was carried out between the variable cost of ads investment and the income brought by the ads, and the distributions of ads value and ads value probability were derived in turn. Finally, the variations in sports ads value were analyzed under different initial income growth rates, long-term income volatilities, long-term cost volatilities, and mean regression coefficients. The analysis results prove the effectiveness of our model. This research has immense values in that it breaks through the limitations of index samples, EIS, and evaluation method. If time and fund permit, the future research will expand the sample size, improve the survey method, and elevate the effective recovery rate of samples.

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