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Applying MSEM to Analyze People's Cognitive Behavior towards Virtual Reality Sport Experience

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Abstract. Since the traditional Structural Equation Modeling is unable to correctly grasp the preferences and behaviors of consumers at multiple levels, this study combined the virtual reality experience model to analyze the motivations and cognitive behaviors of the public towards sports and fitness. The factor analysis was adopted to measure the latent variables of the virtual reality sports experience function, and then Multilevel Structural Equation Modeling was conducted based on the latent variables to find out the optimal model combination and the best path relationship between people's experience situations and latent variables, to truly grasp the motivations and goals of people's sports experience. The empirical results showed that the main factors of the latent variables of people's satisfaction and loyalty of the group level were different from those of the individual level, which indicated that there was a difference between the group and individual sports preferences in virtual reality sports experience, and it indirectly affected the consumption intention of the group and the individual for virtual reality sports experience.

Keywords: Multilevel Structural Equation Modeling (MSEM), Virtual Reality (VR), consumption intention.

1. Introduction

With the advancement of information technology, emerging industries have the momentum for growth and potential huge production value, and the sports industry is also growing rapidly with the widespread application of digital technology. According to the data of [14], the Global Sports Technology Market Size was valued at USD 20.13 billion in 2022, and the Worldwide Sports Technology Market is expected to reach USD 76.39 billion by 2032, demonstrating the development potential of the sports industry. On the other hand, the outbreak of the COVID-19 pandemic in 2020 has changed people's consumption and exercise habits, indirectly giving opportunities to combine technology and sports fields to create more diverse sports products, services and business models. [10] pointed out

that the pandemic has promoted the rise of virtual events around the world, and cross-border and cross-domain sports exchanges are held online. With pandemic prevention considerations, people have reduced their going out and socializing, creating a global trend of home gym, and giving rise to the vigorous development of sports technology. In the post-pandemic era, the sports industry has integrated technologies such as 5G, sensing devices, Artificial Intelligence (AI), and Virtual reality (VR) to provide consumers with a more diverse experience. In other words, since the COVID-19 pandemic, whether it is for leisure sports, consumption, education, learning, or emotional communication, people's huge demand for digital remote interaction has been triggered. The breakthrough development of 5G communications, AI, imaging and other technologies also provides a new interactive experience for sports and leisure, and pushed mankind into the stage of digital transformation, allowing the concepts of virtual and reality to be realized in human life. The development of VR technology and equipment is an important key to promote the mixing of reality and VR. Through the aid of innovative equipment, we can overcome the limitations of human mobility, enhance the sense of realism of long-distance interaction and the benefits of sports and leisure, reduce the cost and risk of outdoor sports, increase people's willingness to play sports, which is an important way to alleviate stress by promoting the physical and mental health of the people. [15] indicated that VR technology can not only simulate the natural environment and promote the sense of participation and enjoyment of sports, but also meet the needs of different groups through customized virtual environments, thus increasing the degree of participation and time spent in sports. [30] hold a similar view, arguing that different applications of VR can create new value in the sports industry, including new marketing methods and business models, and sports consumers can obtain more innovative and diversified interactive experiences through VR [30]. The current applications of VR in the sports industry include sports event broadcasting, sponsor relations and fan management, sports retail, sports museums, sports training and analysis, sports participation, and sports facilities [31].

Since each person has different athletic abilities, the goals they aim to achieve through exercise also vary. VR can also allow users to customize their exercise settings and scenarios according to their preferences and goals. For instance, some VR apps can let users choose different levels of difficulty. [2] indicated thatVR technology not only simulates natural environments, enhancing the sense of engagement and enjoyment in exercises, but also meets the needs of different groups through customized virtual environments, thereby increasing exercise participation and duration. VR not only brings exercise benefits to regular users but also makes it easier for individuals undergoing rehabilitation to use and achieve the desired rehabilitation effects.In the virtual world, real-life scenarios can be created for physical therapy exercises such as stretching, strength training, gait training, coordination, balance, and functional practice through task-based games. These tasks can be customized based on questionnaires or personal preferences and include activities like moving a cup to a designated location, picking fruit from trees, and kicking a ball [16]; [40].

The related products of the combination of VR with sports equipment have also been launched. The relevant research on consumer behavior of VR sports technology also provides reference information for the continuous expansion of the sports industry. As can be seen from the relevant literature, the issue of consumer behavior towards VR sports technology is mostly explored from the perspective of technology acceptance. For exam-

ple, [26] utilized the Technology Acceptance Model (TAM) to explain user attitudes and behavioral intentions in a VR surfing experience. [8] explored VR acceptance through the TAM. [43] proposed an extended version of the TAM that addresses some aspects of VR. Nonetheless, there are still other aspects of consumer behaviors that can be explored in exploring consumer behavior towards VR. For example, consumers' use of VR sports technology not only includes individual participation, but also group participation. This also means that there are different motivations and purposes for individual and group participations, so it is not suitable to analyze the motivations and purposes of people's multilevel leisure sports by traditional SEM. [30] also stated that empirical research that focused on consumer behavior at the intersection of sport content and media technology acceptance is limited. On the other hand, a general framework incorporating various consumers' contributions as main antecedents of customer satisfaction and loyalty, is lacking. Therefore, this paper examined the influence of individual and group consumers on consumption intention in terms of loyalty and satisfaction of VR consumers.

VR sports experience can change people's movement patterns. Elevating fitness to a gaming role will bring a whole new definition to exercise. The effort you put into VR sports will reap immediate in-game rewards and long-term health benefits.

2. Literature Review

Communication with consumers has been the focus of many sports service-related industries [1]; [9]. Generally speaking, consumers' evaluation of the individual's physical and mental pleasure and actual experience during the process of using facilities and enjoying services can be regarded as consumer satisfaction. [17] pointed out that consumer satisfaction is a perception of pleasure or discomfort that an individual obtains after comparing the perceived benefits of a product or service with his or her own expectations. This concept can be found in [41], which also believes that consumers' evaluation of their satisfaction with a product or service is based on a comparison of their prior expectations and their subsequent performance obtained after the actual experience. When consumers believe that the subsequent performance evaluation of the product or service is higher than the original prior expectations, there will be a result of satisfaction, and otherwise, dissatisfaction. It can be seen from the above definition that consumers or participants' comparison of their previous expectations or past experiences with their feelings after actual experience is influenced by various personal factors and environmental factors. Therefore, consumers' actual feelings and personal experiences of participating in activities are particularly important. VR devices for different sports provide consumers with various personal experiences. The quality of these experiences is worthy of further exploration on the satisfaction with the VR devices or services for the sport.

How to promote loyalty has always been the goal of marketers for business organizations, as consumers' higher consumption intention on a product or service means a higher level of loyalty. [34] believe that customer loyalty consists of the commitment of customers to a brand or company to maintain a long-lasting relationship, which will be manifested through attitudes and behaviors. Attitudes include the intention to repurchase or purchase other products of the company, the willingness to recommend the company to others, and to reduce the loss of competition; while behaviors include repeat purchases, purchasing other products of the company, and recommending the company

to others. [21] suggested that there are two types of factors that contribute to consumer loyalty, including customer loyalty generated when the services and products offered by a company are superior to those of other brands, and the likelihood that a customer will repurchase the brand in the future or favor another brand. Thus, it is worthwhile to explore whether the hands-on experience and use experience of VR sports devices are good enough for consumers to choose the products and services once again. In addition, [45] proposed the "Loyalty Triangle" model as a framework for building customer loyalty, which consists of three dimensions: (1) service process: the process of service operation, which includes all activities that require the involvement of the customer and the service provider; (2) value creation: including value addition and acquisition; (3) database management/communication: creating a database of customer preferences, providing special services to customers, and utilizing customer contacts such as advertising letters and event notifications. Through these three dimensions, a company or organization can better focus on its consumers.

When weighing the likelihood of purchasing a product or service, consumers often make decisions on purchasing based on their own perceptions of the product or service. According to [44], consumer intention is a subjective tendency to a particular product formed on consumers' own experiences and the collection of external information about the product during the process of purchasing the product. [11] considered that the consumer's main reason before his or her making the decision on purchasing a product is that he or she has the need for the product, and the consumer decides to purchase the product to satisfy that need, while the evaluation criteria are based on personal experience and the external environment. Thus, consumer intention is a subjective decision. This is consistent with [3] Theory of Planned Behavior, which states that behavior intention occurs before the actual behavior, and behavior intention is an important basis for predicting the occurrence of the behavior. In other words, VR devices of different sports provide consumers with different hands-on experiences, and it is worthwhile to further analyze whether they generate positive consumption intentions, and what factors influence consumption intentions.

In terms of the relationship between variables, [13] explored the evolution of Marketing 4.0 and empirically examined its impact on customer satisfaction and purchase intention. The finding showed that the impact of customer satisfaction on purchase intention is highly significant. [33] on E-commerce also demonstrated that customer satisfaction positively affects purchase intention. On the other hand, related studies also indicated the impact of loyalty on consumption intention [5]; [12]; [18].

3. Research Methods

This study focused on analyzing people's experience and cognitive behaviors of sports and fitness in the context of VR sports experience. The online people's sports experience with VR was sampled and analyzed, the factor analysis was adopted to measure the latent variables of the VR sports experience function, and Multilevel Structural Equation Modeling (MSEM) based on the latent variables was used to find out the best model combination and the best path relationship between people's experience situation and the latent variables. The purpose was to grasp the motivations and goals of people's sports

behaviors, and to establish the optimal sports experience model as well as physical and mental health strategies based on the people's motivations and demand for leisure sports.

In this study, we used factor analysis to analyze people's cognitive behavior towards VR sports and fitness experience, divided the participants of VR sports experience into individuals and groups, and established three latent variables, namely satisfaction, loyalty, and consumption intention. At the same time, the optimal path relationship between the latent variables was established with MSEM. Multilevel data are often characterized by clustered data, which makes the measured sample data have special dependencies, resulting in violation of the assumption of sample independence and invalidating the statistical test. Normal regression analysis and variance analysis cannot deal with this problem, so multilevel analysis techniques must be adopted. Otherwise, the analysis data wouldl be confounded by the hierarchical relationships and lead to erroneous statistical conclusions.

Recent studies have utilized the SEM architecture to deal with multilevel data for Multilevel SEM (MSEM), such as [35]; [27]; [42]; [19]; [20]; [22]; [28]; [32]. Traditional MLM analysis and SEM are independent and unrelated statistical techniques, each with its own merits. If a database has both multilevel structure and latent variable estimation needs, it is necessary to combine these two analytical methods. Therefore, MSEM has been developed to solve the problems of multilevel data structure and latent variable estimation at the same time [6]; [7]; [37]; [38]; [23]; [25]; [29]. In this study, factor analysis was used to measure the latent variables of the VR sports experience function, and based on the latent variables, MSEM was conducted to find out the optimal combination of the models and the optimal path relationship between people's experience situation and the latent variables. The purpose was to understand the motivations of people's sports behaviors and consumption intentions, and to optimize the benefits of sports and VR technology.

The basic hypotheses of the MSEM of this study are as follows.

H1: People's satisfaction with VR sports and fitness experience has a positive effect on consumption intention.

H2: People's loyalty to VR sports and fitness experience has a positive effect on consumption intention.

H3: People's satisfaction with VR sport and fitness experience has a positive effect on loyalty.

Since people of VR sports experience includes both individuals and groups of people with different motivations and purposes, it is not suitable to analyze the motivations and purposes of people's multilevel leisure sports with traditional SEM. This study mainly applied MSEM to explore different groups of people's demand for sports functions in VR sports experience, and conducted the estimation and analysis of the potential contextual variables to grasp the demand of individuals and groups of people in VR leisure sports experience, and to improve the functional benefits of VR sports experience. The aim was to propose the best VR sports experience marketing strategy in an accurate and customized manner to achieve the goals of optimizing people's needs of physical and mental health, physical fitness, and recreation.

According to [37]; [39], in a multilevel data structure, observations at the group level are represented by averages at the individual level, so that the estimates of the intergroup variables contain information about the intragroup variables. In this case, the S PW matrix is the maximum likelihood estimator of the parent matrix ($\sum W$) But the S' B matrix is not the maximum likelihood estimator of the intergroup matrix ($\sum B$). Instead, it is the

linear integration weighted maximum likelihood estimator of the intergroup matrix ($\sum B$) and the intragroup parent matrix ($\sum W$), as shown in the following two equations.

$$S_{PW} = \sum W \tag{1}$$

$$S'_B = \sum W + C_g \sum B \tag{2}$$

In multilevel data, the observation levels of individual and group levels are different, and the number of people C_g in each group in Eq. (2), is used for weighting. When groups are equal in size, C_g is a fixed constant, and the model is called a balanced model; in an unbalanced model with unequal group sizes, C g is a variable. [37]; [39] suggested to ignore the effect of group size differences and replace the C g weight with a post hoc estimate of group size (c^*), which is very close to the average group size, to derive an intergroup observation matrix. The purpose is to simplify the model and achieve the convergence of the MSEM model. c^* is defined as follows.

$$C^* = \frac{N^2 - \sum_{g=1}^{G} C_g^2}{N\,(G-1)} \tag{3}$$

where N is the total number of samples and G is the number of groups. Eq. (3) is the Limited Information Maximum Likelihood (LIML) solution, which is called MUML solution (MUthén's ML) by [37]; [39] and pseudobalanced solution (PBL) by [36]. S'_B is very close to the estimate of $\sum B$ when the sample sizes for intergroup and intra groups are both large. But, when the sample size is small, the bias becomes more severe and the parameter estimates and standard deviations become incorrect. Therefore, the analysis of the MSEM model in this study followed the two-stage procedure suggested by [4], where the most appropriate measurement model is identified and then followed by structural model analysis. The intergroup and intragroup structural models with latent variables (η) are defined as follows.

$$\eta_B = \alpha_B + B_B \eta_B + \varepsilon_B \tag{4}$$

$$\eta_W = B_W \eta_W + \varepsilon_W \tag{5}$$

Eq. (4) and Eq. (5) define the intergroup and intragroup matrix relationships with latent variables of VR sports experience in this study, i.e., the basic form of MSEM.

Since the parent intragroup variance ρ_w^2 and the parent intergroup variance $\rho_b^2 p$ of the vector of variables derived from the sample observation data of the people of VR sports experience is an unbiased statistic, if the ratio between the intergroup variance and the total variance of the variables, i.e., ICC (Intra-Class Coefficient), is measured, the intergroup heterogeneity or intragroup homoscedasticity of the observed variables can be analyzed, as shown in Eq. (6).

$$ICC_M = \rho_M = \frac{\rho_b^2}{\rho_b^2 + \rho_w^2} \tag{6}$$

ICC_M represents the proportion of intergroup variation in the variance of the sample observations. If ICC_M is less than 0.3, it means that the intergroup variation is not

significant and can be handled by the traditional method. On the contrary, if ICC_M is very large, it means that the intergroup variation is significant and must be handled by the multilevel analysis technique [18], or it will result in biased statistical estimation. According to the observed values of the sample of people of VR sports experience in this study, ICC_M was 0.68, which indicated that there were group activities and multilevel data characteristics in the games and sports of VR sports experience, so this study adopted MSEM for empirical analysis.

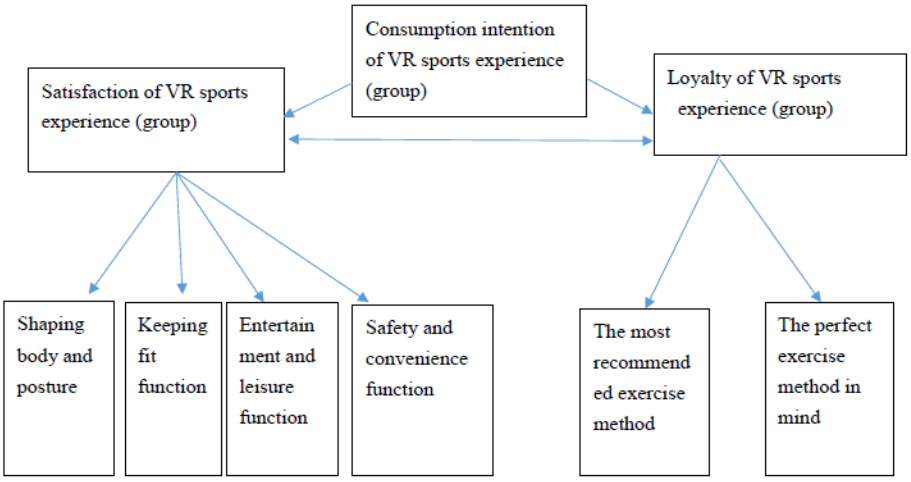
According to [24], the estimated statistic of the intergroup matrix is affected by the sample characteristics, and when the ICC between groups is low, the estimation of factor loadings is prone to be biased, resulting in the underestimation of the error variance and standard deviation, which leads to the rejection of the null hypothesis and committing the statistical Type I error. Therefore, [36] suggested that the sample characteristics should be homogeneous within groups, and the differences should be significant between groups. Also, when the number of samples in each group is not equal, the parameterization should be performed with a more stringent Type I error rate (e.g., a = 0.01). The larger the number of samples and groups, the more complicated the statistical estimation model. The multilevel structural model analysis must be based on a solid measurement model to have appropriate estimation solutions for the parameters measured. Therefore, this study was based on the two-stage MSEM analysis suggested by [29] to find out the most appropriate measurement model, and then carry out the structural model analysis to explore the path relationship between the satisfaction, loyalty and consumption intention of individuals and groups of VR sports experience. The MSEM of the motivations and purposes of the people who had VR sports experience in this study is shown in Figure 1 below.

Group-Level Structural Equation Modeling Path Relationships

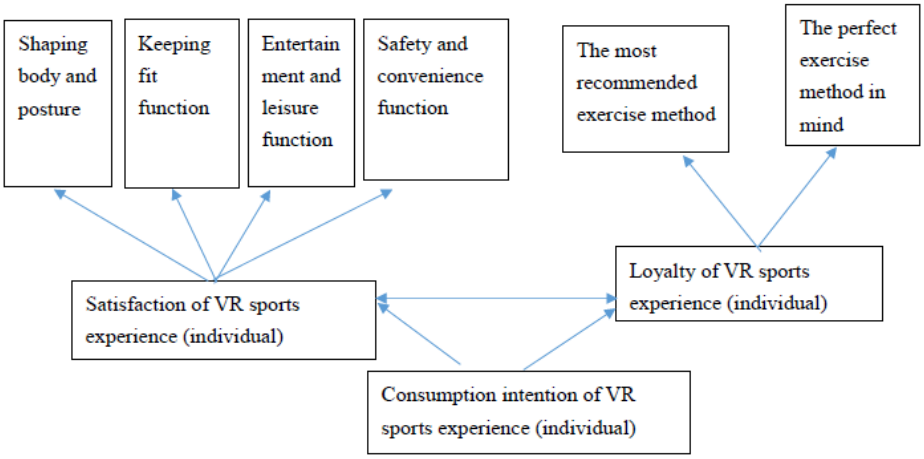
Figure 1 shows that the upper level is the group-level path relationship. The explanatory variable of people of VR sports experience on the left side extracted a corresponding group-level latent contextual explanatory variable (VR sports experience group's satisfaction), and another group-level latent contextual explanatory variable was on the right side (VR sports experience group's loyalty), and the dependent variable in the middle extracted a corresponding group-level latent contextual explanatory variable (VR sports experience group's consumption intention), which is called the latent contextual dependent variable. The three latent variables can be used as important variables in the structural model to conduct regression analysis among the latent variables. Similarly, the lower level is the individual-level path relationship, and the regression analysis between latent variables was also conducted.

4. Empirical Analysis and Results

The sample data of this study were sorted from the data on the people of VR sports experience collected from January to June 2024 through a digital questionnaire. The purpose of this study was to explore the motivational behaviors of the people of VR sports experience, analyze the impact of the satisfaction and loyalty of the motivational behaviors of the VR sports experience groups and individuals on their consumption intention of VR sports experience, in order to understand the relationship between the latent variables of the participants in VR sports experiences such as interactive games, dance, yoga and



(a) Group-Level Structural Equation Modeling Path Relationships



(b) Individual-Level Structural Equation Modeling Path Relationships

Fig. 1. Multilevel Network Structural Equation Modeling (MSEM) for People of VR Sports Experience

qigong, to propose customized marketing service strategies to enhance the consumption intention of people of VR sports experience, and to improve people's goal of sports as well as their physical and mental health.

The sample data of this study consisted of 62 different VR sports experience groups and 1650 VR sports experience individuals. Among the 62 VR sports experience groups, there were 10 female groups, 32 male groups, and 20 mixed groups of women and men. Most of the people of VR sports experience were middle-aged people between 40 and 50 years old (accounting for 41.6%). A total of 1,650 questionnaires were collected as the samples of people of VR sports experience, of which 1,425 were valid, including 786 (55.2%) were from women and 639 (44.8%) from men, with the majority of the participants being women. In the groups of VR sports experience, the minimum number of participants was 6, the maximum number was 25, and the average number of participants in the groups of VR sports experience was 16.5 persons.

Based on the sample data, two latent independent variables "satisfaction with VR sports experience" (with four items, Cronbach's a =.92), "loyalty to VR sports experience" (with two items, Cronbach's a = .91), and the latent dependent variable "consumption intention" (Cronbach's a = .95) were chosen via factor analysis. The reliability of these three latent variables was high, indicating good data consistency.

In this study, Mplus8 was used for the empirical analysis of the MSEM, which has the advantage of directly calculating the covariance matrix of the sample without the need to measure the intergroup and intragroup variance matrix relationships, so that the data have consistency and completeness.

Table 1. Definition of input and output variables

Items of participants' motivational behaviors	Narrative statistics			Sa: Satisfaction with VR sports experience				Lo: Loyalty to VR sports experience		Cu: Consumption intention	
	M	SD1	SD2	Sa1	Sa2	Sa3	Sa4	Lo1	Lo2	Cu1	Cu2
Sa1: Shaping body and posture	3.61	0.25	0.21	1.00	0.82	0.78	0.75	0.72	0.79	0.82	0.81
Sa2: Keeping fit function	3.36	0.12	0.35	0.66	1.00	0.76	0.88	0.67	0.76	0.88	0.80
Sa3: Entertainment and leisure function	3.82	0.31	0.28	0.71	0.68	1.00	0.88	0.82	0.78	0.78	0.71
Sa4: Safety and convenience function	3.38	0.14	0.34	0.68	0.73	0.72	1.00	0.65	0.65	0.86	0.82
Lo1: The most recommended exercise method	3.58	0.22	0.18	0.82	0.68	0.83	0.78	1.00	0.68	0.88	0.86
Lo2: The perfect exercise method in mind	3.47	0.34	0.26	0.67	0.72	0.73	0.72	0.85	1.00	0.81	0.89
Cu1: Great value for money	3.39	0.28	0.32	0.83	0.75	0.69	0.65	0.76	0.62	1.00	0.91
Cu2: Planning to purchase	3.35	0.24	0.27	0.64	0.63	0.81	0.68	0.59	0.82	0.82	1.00

Note: The lower triangles are the individual-level correlation coefficients of VR sports experience and the upper triangles are the group-level (group) weighted correlation coefficients. SD1 is the standard deviation of 1425 VR sports experience individuals at the individual level; SD2 is the weighted standard deviation of 62 VR sports experience groups.

As shown in Table 1, for the statistics and correlation coefficients of the 62 VR sport experience groups with the 1425 samples, the mean score of satisfaction, loyalty and consumption intention of VR sport experience participants ranged from 3.35 to 3.82 out of 5. The variance of the scores of motivational behaviors of VR sport experience participants was consistent, with the standard deviation ranging from 0.14 to 0.34. The correlations between items were all significant at the 0.01 level, with coefficients ranging from 0.59 to 0.91, and the correlations between the two consumption intention items (Cu1 and Cu2) were even higher than 0.80, which indicated that the consistency of the questionnaire items was very high.

CFA was conducted on eight observational variables to verify the validity of three latent variables, namely "satisfaction with VR sports experience", "loyalty to VR sports experience" and "consumption intention". The ICC_M was measured to be 0.68 according to the sample data of this study, so the data structure had multilevel characteristics. In the CFA test, the single-level CFA was firstly conducted on the 1425 individual-level sample data to confirm the factor structure of the VR sports experience at the individual level, and then multilevel CFA was carried out to test the factor validity of the three latent variables at the group level. There were 8 observed variables for the single-level CFA model validation. The independent model (SEM1) had no factor constraints and no correlation between the observed variables. The other single-level CFA models were divided into three models based on whether the latent variables were correlated or not: the orthogonal three-factor model (SEM2), which assumed that the correlation among the three latent variables was zero; the diagonal three-factor model (SEM3), which also meant that there was a correlation among the three latent variables and correlation analyses were carried out; and the independent variable single-factor model (SEM4), which assumed that the "satisfaction with the VR sports experience" and "loyalty to VR sports experience" were integrated. The results of the four model fit test indicators are shown in Table 2.

able 2 shows that, among the three hypothesized models, the best data fit was obtained from the diagonal three-factor model (SEM3), with $X^2(48)$ = 378.66, p¡.001, X^2/df=9.62, RMSEA=0.086, CFI=0.971, TLI=0.952, and SRMR=0.062. Comparatively, the fit of three-variable orthogonal SEM2 and independent variable single-factor model SEM4 was not good, indicating that the three latent variables were not independent and uncorrelated, nor were they combined into a single latent variable. Therefore, in this study, the three-variable diagonal model was the best fit for the individual-level factor structure path, and this model was used as the basis for the multilevel CFA analysis.

According to Figure 2, the factor loading values of the measured variables of the latent variables were all greater than 0.80, indicating that the explanatory power and consistency within the latent variables were very high. The correlation between the two latent variables was 0.86 ($p < .001$), indicating high satisfaction with the VR sports experience and high loyalty to the VR sports experience. The correlation between the two independent variables and the dependent variable was also very high. The correlation coefficients between "satisfaction with VR sports experience " and "consumption intention" as well as "loyalty to VR sports experience and "consumption intention" were both 0.85 ($p < .001$).

According to the MSEM, the structure of latent variables at both the individual level and the group level was considered for analysis. This study retained the above-mentioned best model at the individual level (the diagonal model of three latent variables). The latent variables at the group level were sequentially divided into four different structural models.

The first multilevel model (MSEM1) was an independent model, where the eight latent variables were assumed to be irrelevant and independent of each other. This model did not make any assumptions or restrictions on all latent variables, and was regarded as the most elastic baseline model among the group-level path. The structure of latent variables at the group level was set according to the individual level model, which was divided into a three-variable orthogonal model (MSEM2), a three-variable diagonal model (MSEM3), and an independent variable single-factor model (MSEM4). The fit test results of these four groups of multilevel CFA models are shown in Table 2.

As seen in Table 2, MSEM1 did not have any constraints on the latent variable structure, and the results of this model's fit test were the least satisfactory, with $X^2(68)$ =693.78, $p < .001$. The SRMRB indicator (0.768) at the group level showed a very large standardized difference between groups at the group level, and a relatively small residual difference at the individual level (SRMRW=0.068), indicating that the MSEM1 model fit was most unsatisfactory. In the group level, the fit test results were even more unsatisfactory if the three latent variables were assumed to be under the triple orthogonal model (MSEM2), with $X^2(63)$ =641.62, $p < .001$, RMSEA=0.092, indicating that the three latent variables were partially correlated at the group level, and the modeling at the group level was poor as indicated by SRMRB=0.612. As to the two models MSEM3 and MSEM4, the model fit test results were very close. However, the three-factor diagonal model (MSEM3) was found to be better, as shown by the test indicators of $X^2(63)$ =252.82, $p< .001$, RMSEA=0.028, SRMRB=0.112, and SRMRW=0.032.

According to the results of CFA test in this study, the three-factor diagonal model was the best model in the individual level of people of VR sports experience, and the latent independent variables were two-factor diagonal in the group level. Therefore, this study used the MSEM3 structural model to analyze the behavioral motivation and satisfaction of people of VR sports experience as well as the influence of loyalty on consumption intention.

The empirical results of the MSEM in this study are as shown in Figure 2. The R^2 at the group level and the R^2 at the individual level of the model were 0.86 and 0.82, respectively, which indicated that the two latent independent variables in the model can effectively explain the latent dependent variable.

According to the results of the empirical analysis, the path relationship of the group level MSEM was consistent with the basic hypotheses of this study. The satisfaction with VR sports experience had a positive impact on loyalty, the influence coefficient was 0.13, and t-value was significant, which meant that there was not much correlation between the two latent independent variables, and this would not lead to the problem of collinearity statistical fallacy between the latent independent variables. Among the factors of the latent independent variable, satisfaction with VR sports experience (Sa), the most influential factor was the entertainment and leisure function of VR sports experience (Sa3), with an influence coefficient value of 0.38 and a significant t-value, which indicated that the VR sports experience (group) paid the most attention to the entertainment and leisure function of the VR sports experience, and this factor also indirectly influenced the group's consumption intention. The second factor was that VR sports experience had the function of shaping body and posture, with an influence coefficient value of 0.35 and a significant t-value, which indicated that VR sports experience groups believed that the function of shaping body and posture had the second largest influence on their satisfaction. Among

Table 2. Definition of input and output variables

Intragroup	Intergroup	X^{2*}	df	X^2/df	RMSEA	CFI	TLI	SRMR	
								Intragroup	Intergroup
Single-level CFA									
SEM1 independent model		4033.12	52	98.62	0.365	0.000	0.000	0.486	
SEM2 three-variable orthogonal		1282.62	50	24.36	0.279	0.732	0.726	0.425	
SEM3 three-variable diagonal		378.66	48	9.62	0.086	0.971	0.952	0.062	
SEM4 independent variable single-factor		821.25	50	16.71	0.261	0.866	0.887	0.162	
Multi-level CFA									
MSEM1 three-variable diagonal	Independent model	693.78	68	10.26	0.065	0.896	0.936	0.068	0.768
MSEM2 three-variable diagonal	Three-variable orthogonal	641.62	63	10.69	0.092	0.923	0.942	0.055	0.612
MSEM3 three-variable diagonal	Three-variable diagonal	252.82	63	4.36	0.028	0.972	0.972	0.032	0.112
MSEM4 three-variable diagonal	Independent variable single-factor	371.60	61	6.25	0.046	0.943	0.951	0.039	0.267

The X^2 values of all single-level and multi-level models reached the significant level of 0.001.

the important factors of the group's loyalty (Lo) to VR sports experience, the most recommended exercise method (Lo1) had the largest influence coefficient, with a coefficient value of 0.42 and a significant t-value. This indicated that the VR sports experience group believed that they would recommend their teammates and friends and relatives to participate in the VR sports experience activities together, and they had a rather enthusiastic loyalty, and loyalty also indirectly affected the consumption intention of the VR sports experience group. Of the two latent independent variables, the loyalty of VR sports experience activities had a greater effect on the latent dependent variable (consumption intention), with a coefficient value of 0.45 and a significant t-value, indicating that the consumption intention on VR sports experience (group) was strongly influenced by the loyalty of the public.

As shown in Figure 2, the paths of latent variables in the individual level MSEM were all consistent with the basic hypotheses of this study. People's satisfaction in VR sports experience activities had a positive impact on customer loyalty, with an influence coefficient of 0.16, a significant t-value, and the influence coefficient was within a reasonable range that did not lead to covariance statistical problems among the latent independent variables. In the individual-level model, the main factor affecting the satisfaction of individuals in VR sports experience activities (Sa) was that VR sports experience has the function of shaping body and posture (Sa1), with an influence coefficient of 0.38 and a significant t-value, which indicated that the VR sports experience people paid more attention

to the body shape and appearance than the entertainment, leisure, keeping fit functions, and it indirectly influenced people's consumption intention. The main factor of loyalty (Lo) of VR sports experience people (individuals) was the belief that VR sports experience was a perfect exercise method (Lo2), with an influence coefficient value of 0.40, and a significant t-value. This indicated that the psychology of perfect exercise method (Lo2) of VR sports experience was the biggest factor to establish people's loyalty to VR sports experience and it indirectly affected people's consumption intention a great deal. Of the two latent independent variables, the one with greater influence was the loyalty to VR sports experience (Lo), with an influence coefficient of 0.47 and a significant t-value.

The empirical analysis found that the behavioral motivations and preferences of the group level and individual level of VR sports experience were different, leading to differences in satisfaction and loyalty, which indirectly affected the consumption intention of VR sports experience. The behavior of VR sports experience at the group level had some of the attributes of individual people, but the VR sports experience group, considering the common recreational and leisure behaviors of the group and the spirit of mutual assistance, formed another independent group. Therefore, in order to promote the physical and mental health of busy modern people and facilitate leisure sports anytime and anywhere, the needs for sports and leisure by groups and individuals must be comprehensively grasped in the function of VR sports experience and digital related virtual effects, so as to accurately and efficiently provide customized sports and leisure services, and to maximize the benefits of sports, entertainment and health.

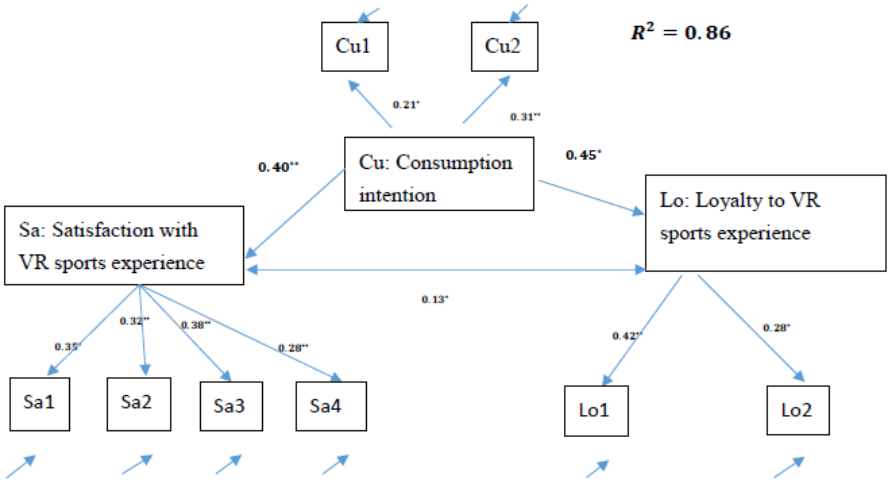
5. Conclusion and Suggestions

5.1. Conclusion

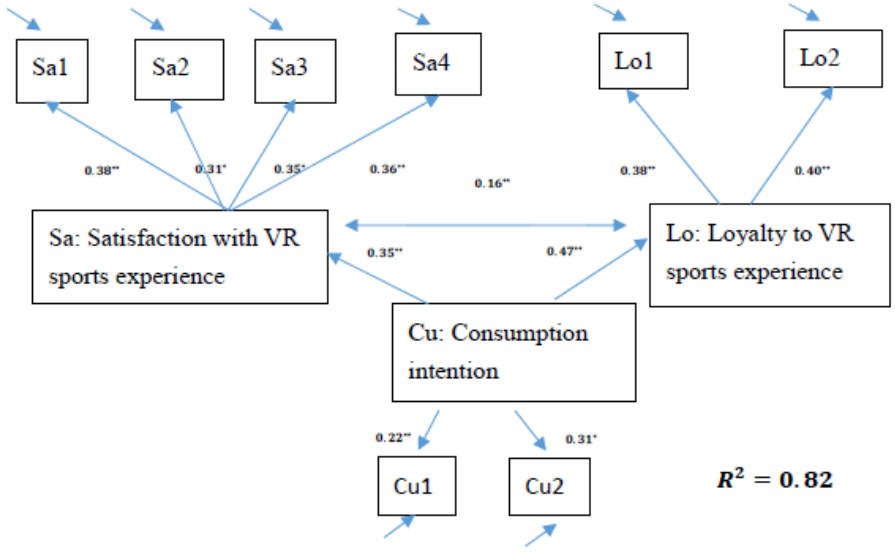
Among the users of VR sports experience, there were significant differences in the demand for sports experience and leisure attributes between groups and individuals, and the traditional SEM model cannot correctly capture the preferences and behaviors of tourists at multiple levels. The empirical results showed that the main factors of the latent variables of satisfaction and loyalty of the group level were different from the main factors of the individual level, which indicates that the sports preferences of VR sports experience groups were different from the sports preferences of individuals, and this indirectly affected the sports consumption intention of groups and individuals.

5.2. Suggestions

1. For VR sports experience operators
   According to the results of this paper, the motivation of VR sports experience groups and individuals was different, leading to differences in their satisfaction and loyalty, and indirectly affecting their intention of exercise and consumption. In terms of the latent variables of satisfaction, VR sports experience groups paid most attention to the recreational and leisure function of VR sports experience (Sa3), while VR sports experience individuals paid attention to the body and posture shaping function of VR sports experience (Sa1). Therefore, it is recommended that related operators of VR sports experience should make timely adjustments according to the functions



(a) Group-Level Structural Equation Modeling Path Relationship



(b) Individual-Level Structural Equation Modeling Path Relationship

Fig. 2. Multilevel Structural Equation Modeling Path Relationships for VR Sports Experience People Note: The above path coefficients are standardized coefficients; **p < 0.05

and services emphasized by VR sports experience in the future planning of VR sports experience functions and services to meet the demand, such as adding the types of VR sports experience games and sports, and increasing the functions of group cooperation and the interactivity of sports. In addition, the main purpose of VR sports experience for individual participants is shaping body and posture, so the operators must provide a variety of on-demand courses and exercise methods, not only to make sports as fun as playing, but also to enable individual participants to get more involved in the VR sports through the provision of accurate service content.

2. For people of VR sports experience
   The results of this study showed that in terms of loyalty, VR sports experience groups thought that VR sports experience was the most recommended exercise method (Lo1), while VR sports experience individuals considered VR sports experience as the most perfect way of exercise and leisure (Lo2). Thus, both group and individual VR sports experience participants, after experiencing special and VR leisure sports, had positive behavioral motivations for the functions and benefits of VR sports experience, and achieved the sports benefits of physical and mental health. It is thus recommended that people who want to have VR sports experience may choose the suitable devices to achieve better sports benefits. For example, some people suffer from gym phobia, because they are too demanding but afraid of failing and causing embarrassment. At this point, VR sports experience devices are suitable for individuals to exercise and workout at home. At the same time, with the high-tech 3D dynamic capture technology or real-time sports posture correction and trajectory guidance, it allows individuals to have the opportunity to choose the right VR device to maximize the benefits of exercise, and to engage in exercise in a very safe environment, which will increase the consumption intention.

References

1. Abeza, G., O'Reilly, N., Reid, I.: Relationship marketing and social media in sport. International Journal of Sport Communication 6(2), 120–142 (2013)
2. Ahmad, M.A., Singh, D.K.A., Mohd Nordin, N.A., Hooi Nee, K., Ibrahim, N.: Virtual reality games as an adjunct in improving upper limb function and general health among stroke survivors. International journal of environmental research and public health 16(24), 5144 (2019)
3. Ajzen, I.: The theory of planned behavior. Organizational Behavior and Human Decision Processes 50(2), 179–211 (1991)
4. Anderson, J.C., Gerbing, D.W.: Structural equation modeling in practice: A review and recommended two-step approach. Psychological bulletin 103(3), 411 (1988)
5. Anderson, K.C., Knight, D.K., Pookulangara, S., Josiam, B.: Influence of hedonic and utilitarian motivations on retailer loyalty and purchase intention: a facebook perspective. Journal of Retailing and Consumer Services 21(5), 773–779 (2014)
6. Bentler, P.M., Liang, J.: Two-level mean and covariance structures: Maximum likelihood via an em algorithm. Multilevel modeling: Methodological advances, issues, and applications pp. 53–70 (2003)
7. Bliese, P.D.: An introduction to multilevel modeling techniques. Personnel Psychology 53(4), 1062 (2000)
8. Capasa, L., Zulauf, K., Wagner, R.: Virtual reality experience of mega sports events: A technology acceptance study. Journal of Theoretical and Applied Electronic Commerce Research 17(2), 686–703 (2022)

9. Chanavat, N., Bodet, G.: Experiential marketing in sport spectatorship services: A customer perspective. European Sport Management Quarterly 14(4), 323–344 (2014)
10. Cho, C.H.: Developing a digital ecosystem for sports technology in the post-pandemic era to create business opportunities. National Sports Quarterly 51(3), 45–50 (2022)
11. Cohen, D.: Consumer behavior. New York, Toronto (1981)
12. Das, G.: Linkages of retailer awareness, retailer association, retailer perceived quality and retailer loyalty with purchase intention: A study of indian food retail brands. Journal of Retailing and Consumer services 21(3), 284–292 (2014)
13. Dash, G., Kiefer, K., Paul, J.: Marketing-to-millennials: Marketing 4.0, customer satisfaction and purchase intention. Journal of business research 122, 608–620 (2021)
14. Electronics, S..: Spherical Insights.: Global Sports Technology Market. Spherical Insights (2023)
15. Flowers, E.P., Freeman, P., Gladwell, V.F.: A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels. BMC Public Health 16, 1–8 (2016)
16. Flowers, E.P., Freeman, P., Gladwell, V.F.: A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels. BMC Public Health 16, 1–8 (2016)
17. Fornell, C., Johnson, M.D., Anderson, E.W., Cha, J., Bryant, B.E.: The american customer satisfaction index: nature, purpose, and findings. Journal of marketing 60(4), 7–18 (1996)
18. Foroudi, P., Jin, Z., Gupta, S., Foroudi, M.M., Kitchen, P.J.: Perceptional components of brand equity: Configuring the symmetrical and asymmetrical paths to brand loyalty and brand purchase intention. Journal of business research 89, 462–474 (2018)
19. Goldstein, H., Browne, W.: Multilevel factor analysis modelling using markov chain monte carlo estimation. In: Latent variable and latent structure models, pp. 225–243. Psychology Press (2014)
20. Goldstein, H., McDonald, R.P.: A general model for the analysis of multilevel data. psychometrika 53(4), 455–467 (1988)
21. Griffin, J.: The internet's expanding role in building customer loyalty. direct marketing, 59 (7), 50–53 (1996)
22. Hox, J., Moerbeek, M., Van de Schoot, R.: Multilevel analysis: Techniques and applications. Routledge (2017)
23. Hox, J.J.: Applied multilevel analysis. TT-publikaties (1995)
24. Hox, J.J., Maas, C.J.: The accuracy of multilevel structural equation modeling with pseudobalanced groups and small samples. Structural equation modeling 8(2), 157–174 (2001)
25. Hoyle, R.H.: Handbook of structural equation modeling. Guilford Publications (2014)
26. Huang, Y.C., Li, L.N., Lee, H.Y., Browning, M.H., Yu, C.P.: Surfing in virtual reality: An application of extended technology acceptance model with flow theory. Computers in Human Behavior Reports 9, 100252 (2023)
27. Jedidi, K., Ansari, A.: Bayesian structural equation models for multilevel data. In: New developments and techniques in structural equation modeling, pp. 149–178. Psychology Press (2001)
28. Jöreskog, K.G., Sörbom, D.: Lisrel 8.80. Lincolnwood, IL: Scientific Software International Inc (2006)
29. Kaplan, D., Elliott, P.R.: A didactic example of multilevel structural equation modeling applicable to the study of organizations. Structural Equation Modeling: A Multidisciplinary Journal 4(1), 1–24 (1997)
30. Kunz, R.E., Santomier, J.P.: Sport content and virtual reality technology acceptance. Sport, Business and Management: An International Journal 10(1), 83–103 (2020)
31. Lee, S.Y., Lin, Y.H.: Digital transformation and application of virtual reality in sports industry. Sport and Health 11(2) (Sep 2022)

32. Lee, S.Y.: Handbook of latent variable and related models, vol. 1. Elsevier (2011)
33. Lee, V., Park, S., Lee, D.: The effect of e-commerce service quality factors on customer satisfaction, purchase intention, and actual purchase in uzbekistan. Global Business & Finance Review (GBFR) 27(3), 56–74 (2022)
34. Love Lock Jones, T.O., Sasser Jr, W.E.: Why satisfied customer defect. Jurnal Harvard Business Review 73(6) (2011)
35. Marcoulides, G.A., Schumacker, R.E.: New developments and techniques in structural equation modeling. Psychology Press (2001)
36. McDonald, R.P.: The bilevel reticular action model for path analysis with latent variables. Sociological Methods & Research 22(3), 399–413 (1994)
37. Muthén, B., Satorra, A.: Multilevel aspects of varying parameters in structural models. In: Multilevel analysis of educational data, pp. 87–99. Elsevier (1989)
38. Muthén, B.O.: Multilevel covariance structure analysis. Sociological methods & research 22(3), 376–398 (1994)
39. Muthén, B.O.: Mean and covariance structure analysis of hierarchical data (2011)
40. Norouzi-Gheidari, N., Hernandez, A., Archambault, P.S., Higgins, J., Poissant, L., Kairy, D.: Feasibility, safety and efficacy of a virtual reality exergame system to supplement upper extremity rehabilitation post-stroke: a pilot randomized clinical trial and proof of principle. International journal of environmental research and public health 17(1), 113 (2020)
41. Oliver, R.L.: What is customer satisfaction? Wharton Magazine 5, 36–41 (1981)
42. Ravi, S.: Multilevel statistical models, 3rd edn (2005)
43. Sagnier, C., Loup-Escande, E., Lourdeaux, D., Thouvenin, I., Valléry, G.: User acceptance of virtual reality: an extended technology acceptance model. International Journal of Human–Computer Interaction 36(11), 993–1007 (2020)
44. Schiffman, L., Kanuk, L.: Consumer Behavior. Prentice Hall International Editions Series, Prentice Hall (2000)
45. Shoemaker, S., Lewis, R.C.: Customer loyalty: the future of hospitality marketing. International journal of hospitality management 18(4), 345–370 (1999)

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