Table Tennis Players' Behavioral Intention of Using Smart Bat from Perspective of UTAUT

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Abstract

This study investigated the behavioral intention of table tennis players to use smart bats with the Unified Theory of Acceptance and Use of Technology, and examined the theoretical model fit of this study with the AMOS statistical software. In this study, the questionnaire survey method was adopted, and the table tennis players using smart bats were taken as the research subjects. The findings of this study are as follows. (1) The performance expectancy, social influence, advantageous conditions, and involvement level of players using smart table tennis bats has a significant effect on behavioral intention. (2) The effort expectancy of players using smart table tennis bats has no significant effect on behavioral intention. (3) The level of involvement of players using smart table tennis bats has a moderating effect on the relationship between social influence and behavioral intention. (4) The gender of players using smart table tennis bats has a moderating effect on the relationship between performance expectancy and behavioral intention. (5) The gender of players using smart table tennis bats has a moderating effect on the relationship between effort expectancy and behavioral intention. (6) The experience of players using smart table tennis bats has a moderating effect on the relationship between effort expectancy and behavioral intention. (7) The experience of players using smart table tennis bats has no moderating effect on the relationship between on social influence and behavioral intention. (8) The experience of players using smart table tennis bats has a moderating effect on the relationship between facilitating condition and behavioral intention. (9) The voluntariness of use of smart table tennis bats has no moderating effect on the relationship between social influence and behavioral intention.

Keywords: Unified Theory of Acceptance and Use of Technology (UTAUT), Table tennis player, Smart table tennis bat, Behavioral intention

1 Introduction

With the rapid development of the Internet and the application of innovative technologies, sports technology has gradually enabled the sports industry to have diversified features with a variety of value-added services, and sports participants also get a various experience through sports technology. [1] pointed out, in the sports industry, data analysis, sports performance monitoring, virtual reality applications and sports wearable devices are all the fields in which global enterprises have invested one after another. In addition, Google Health, Amazon and other technology companies have also begun to target wearable devices and investment in the sports industry. This trend is also in line with market statistics. For example, the report [2] indicated that the global sports technology market reached USD 11.7 billion in 2020, and was expected to grow at a compound annual growth rate of 16.8% through 2028, with a chance to reach USD 45.8 billion. There are four areas of significant growth: Smart Stadium, Device, Esports, Analytics & Statistics.

Table tennis has always been one of the key sports development programs in Taiwan. However, the cultivation of good table tennis players cannot be achieved overnight. Meanwhile, table tennis, which is an individual sport, has the characteristics of being fast-paced, physically demanding, and psychologically and emotionally intense. [3] argued that the content and quality of training needs to be arranged in a very strict manner to achieve the victory in the field of table tennis. However, with the evolution of time, sports are moving towards specialized training, and the evolution of training aids and equipment has greatly improved players' performance thanks to the advancement of technology. For example, wearable sports devices are moving away from measurement and monitoring functions and gradually moving towards the direction of using the collected data for more accurate analysis, and related research is also contributing to this direction [4]. For instance, [5] pointed out that the pressure-sensitive board of a smart table tennis bat allows good players to experience important data of each hit, and obtains the parameters

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of the strength, speed, acceleration and trajectory of the swing as well as the hitting point of the player in real time. At the same time, through the calculation and analysis, it can also determine the player's swing efficiency and fatigue decline, to interpret the player's continuous hitting ability in a scientific and objective way. It is learned from the above introduction that the smart table tennis bat can help the players in training and enable the coaches to make technical adjustments for the players via data analysis. Although the smart table tennis bat has been gradually known by table tennis players and coaches, it is worthwhile to further investigate the degree of acceptance of the smart table tennis bat by table tennis players and their willingness to use the smart table tennis bat during actual training. This is one of the motivations of this study.

In general, whether a new technology introduced by the sports industry is widely accepted by sports users is often the focus of concern during the development of the industry. When we discuss the degree of acceptance of a new technology, the Unified Theory of Acceptance and Use of Technology (UTAUT) can be used as a basis for argumentation. As pointed out in the study by [6], the UTAUT can be used for the acceptance of a new technology, and the exploration of the behavioral intentions and subsequent use behaviors. The Unified Theory of Acceptance and Use of Technology (UTAUT) developed by [7] integrates eight theories including the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, a model combining the technology acceptance model and the theory of planned behavior, the model of PC utilization, the innovation diffusion theory and the social cognitive theory. In this paper, the UTAUT can help to explore the degree of players' performance improvement after their using smart table tennis bats, to further understand the players' ease of use of smart table tennis bats. Moreover, it can help to understand the perceptions of coaches and significant others on the use of smart table tennis bats by players. In other words, through the study of applying the UTAUT to investigate the use of smart table tennis bats, the results are expected to provide important information to players, coaches, and even smart table tennis bat developers for subsequent training as well as research and development. This is the second motivation of this study.

Since the development of the UTAUT, many empirical research results have been produced, contributing to the development of related industries. As seen from the literature, there is a diversity of literature on the use of the UTAUT in sports-related fields ([8-11]). From the above studies, it has been found that there are relatively few studies on the application of the UTAUT to smart table tennis bats. However, as sports technology gradually analyzes the scientific data obtained from smart table tennis bats to systematically improve the technical aspects of players, it is worthwhile to investigate smart table tennis bats. This is the third motivation for this study. On the other hand, most research on UTAUT in the past focused on network technology, mobile communications or electronic products, with less attention on sports technology products or equipment. However, currently there are many supply chains for sports equipment and sports goods in Taiwan, coupled with the accumulated profound foundation for the development of information, communications and digital content, which are all conducive to the development of products and applications sports combining technology. Therefore, it is innovative to use UTAUT to explore smart table tennis bats. Furthermore, this paper attempted to apply UTAUT to the field of table tennis, which not only enabled the communication with users of table tennis technology, but also provided relevant information needed for the development of table tennis technology, thereby improving the acceptance of the system, cultivating a population who continues to participate in table tennis, and then driving the output value of the overall sports technology industry. Therefore, this paper took table tennis players as the research subjects, and utilized the UTAUT to explore the players' behavioral intention towards the use of smart table tennis bats, and put forward relevant recommendations based on the research conclusions.

2 Literature Review

2.1 Smart Table Tennis Bat

As electronic technology matures, sports technology is gradually being applied to the development of sports equipment with the popularization of smart phones and the development of cloud technology. Wearable sports devices are moving towards smaller size and larger data storage capacity, using gyroscopes, magnetometers, accelerometers, pedometers and other technologies to obtain user-related data, while players can use the objective and quantitative data collected by the wearable devices to identify training needs and deficiencies, thereby improving training results. In addition to wearable sports devices, the integration of smart concepts into bats is also one of the directions for the development of sports technology. According to [5], after analyzing the algorithms, smart table tennis bats can also understand the swing efficiency and fatigue decline of players, so that the players' ability to hit the ball continuously can be interpreted in a scientific and objective way. All sensory signals are captured simultaneously during the batting process, and the data are analyzed on the computer for the in-depth understanding by the players and coaches using process movies, so that a long-term database of individual players and many players is established. And the system suggests ways for players and coaches to improve and enhance their abilities. Most importantly, standardized test results can be provided for players over a certain training time, informing them of the effects of their improvements and the changes they have made, so that the players are no longer relying on their feelings and subjectivity alone to train and compete.

As a matter of fact, technologies related to smart table tennis bats have already produced research and development results one after another ([12-13]), on the other hand, constructed an overall technology architecture diagram for table tennis sports technology (as shown in Figure 1). From the above-mentioned studies related to smart table tennis bats, through the measurement of

smart table tennis bats and the development of the overall technological architecture, there is a chance to not only accelerate the development and design of table tennis related smart devices, but also to establish the optimal movement patterns so that coaches and players can obtain scientific and quantitative data. This will make training more efficient, and show the results with the assistance of sports technology as well.

Figure 1. Overall technical architecture of table tennis sports technology (Source: [13])

2.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

With the advancement of information technology, the idea of understanding people's adoption of a new technology has been gradually attracting attention, and related research has also developed theoretical models to explain behavioral intention. In other words, whether the new technology can be accepted by the public and whether it meets their needs and utility is worth further exploration. Among the relevant theories, the Unified Theory of Acceptance and Use of Technology (UTAUT) analyzes the influencing factors on a person's behavior. The UTAUT was developed by [7] by integrating eight theoretic models from the past, including the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), the Technology Acceptance Model (TAM), the Social Cognitive Theory (SCT), the Model of PC Utilization (MPCU), the Innovation Diffusion Theory (IDT), the Motivational Model (MM), and A Model Combining the Technology Acceptance Model and the Theory of Planned Behavior (C-TAM-TPB). The UTAUT is summarized into four main determinants: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (ST), and Facilitating Condition (FC), plus four other control variables: Gender, Age, Experience, and Voluntariness of Use. Performance Expectancy is defined as "the degree to which users perceive that the use of a technology system can contribute to the improvement of work performance". In the case of this study, it can refer to the impact of table tennis players' use of smart table tennis bats on the enhancement of their training results.

It can be seen from the definitions of the above dimensions that the integration of the eight theories by the UTAUT makes the model more applicable. As emphasized by [14], the effect of the UTAUT in explaining the variance in the intention to use various types of technology is more than 70%, which proves that the UTAUT is a comprehensive and wide-ranging model. It provides management with an assessment tool for determining whether users will accept the promotion of new technologies. Moreover, the model can also predict and explain users' behavioral intentions regarding new technologies and their actual use behaviors.

2.3 Meaning of Involvement

Since [15] introduced the concept of "involvement" into the field of consumer behavior research, the concept has gradually gained attention and has been applied in various fields. The Consumer Involvement Profile (CIP) proposed by [16] has been used in many studies, and is composed of the following dimensions.

(1) Importance: the value and importance of a product to an individual.

(2) Product Pleasure: the attractiveness of a product and its ability to bring pleasure and favorable feelings.

(3) Product Sign: the product's reflection of personal traits or social status.

(4) Risk Importance: the financial and functional risk of purchasing a product.

(5) Risk Probability: the chance of making a wrong purchase as perceived by the consumer.

Related studies have also used different dimensions to measure involvement ([17-18]), which suggests that it is more difficult to present the complex process of consumers' purchasing a product or service with a single dimension. This is a view echoed by [19], who argued that there is no single indicator that can describe, explain or predict the level of involvement, and multiple dimensions are needed for measurement.

3 Research Method

3.1 Research Structure

According to the purpose of this study and related literature, the causal model of table tennis players' behavioral intention to use smart table tennis bats was investigated, and the causal relationship between the variables was presented by Structural Equation Modeling (SEM). The research structure of this study is shown in Figure 2.

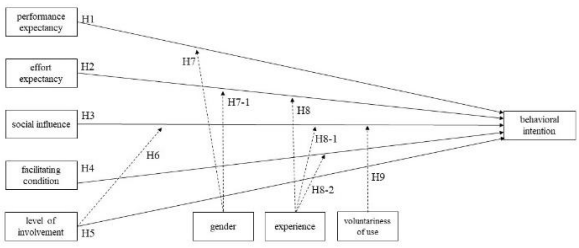

Figure 2. Research structure

3.2 Research Hypotheses

The research hypotheses of this study were proposed as follows according to the research objectives, research questions and research structure.

H1: The performance expectancy of using smart table tennis bats has a positive and significant effect on behavioral intention.

H2: The effort expectancy of using smart table tennis bats has a positive and significant effect on behavioral intention.

H3: The social influence of using smart table tennis bats has a positive and significant effect on behavioral intention.

H4: The facilitating condition of using smart table tennis bats has a positive and significant effect on behavioral intention

H5: The level of involvement of using smart table tennis bats has a positive and significant effect on behavioral intention.

H6: The level of involvement of using smart table tennis bats has a moderating effect on the relationship between social influence and behavioral intention.

H7: The gender of using smart table tennis bats has a moderating effect on the relationship between performance expectancy and behavioral intention.

H7-1: The gender of using smart table tennis bats has a moderating effect on the relationship between effort expectancy and behavioral intention.

H8: The experience of using smart table tennis bats has a moderating effect on the relationship between effort expectancy and behavioral intention.

H8-1: The experience of using smart table tennis bats has a moderating effect on the relationship between on social influence and behavioral intention.

H8-2: The experience of using smart table tennis bats has a moderating effect on the relationship between Schakowsky facilitating condition and behavioral intention.

H9: The voluntariness of use of smart table tennis bats has a moderating effect on the relationship between social influence and behavioral intention.

3.3 Research Subjects

This study was conducted with the research subjects of table tennis players from September 1 to 30, 2023 for a total of one month, in the northern, central, southern and eastern parts as well as the outlying island regions. The convenience sampling was adopted with table tennis players using smart table tennis bats as the target. A total of 350 questionnaires were distributed and 311 valid samples were collected.

3.4 Research Tools

The questionnaire of this study was mainly based on the questionnaire of the research findings of [7] and [20], and was revised and reconstructed with reference to the relevant literature in Taiwan and the previous literature. The Likert 5-point scale was used in this study. There were a total of 36 questions divided into seven dimensions: performance expectancy, effort expectancy, social influence, facilitating condition, level of involvement, voluntariness of use, and behavioral intention.

3.5 Data Analysis Method

The questionnaire data of this study were processed by the statistical software SPSS and AMOS for relevant data processing. Multivariate normality test, reliability and validity analysis, confirmatory factor analysis and fit analysis were performed. Furthermore, a path model within the structural equation modeling framework was employed to analyze the causal relationships among the variables.

4 Research Results

4.1 Sample Characteristics

The majority of the sample in this study were male, unmarried and aged 15-18 years old, with the education level of high/vocational high school. Most of them were students, had an average monthly income of NTD 20,000 or less, were living in the northern part of Taiwan, and had the experience of more than 4 years of bat use. Most of them had more than 15 hours of weekly training, and most of them had ranked 1st or 2nd in the table tennis tournaments.

4.2 Measurement Model Analysis

In this study, the convergent validity and construct validity of the questionnaire were assessed by Confirmatory Factor Analysis (CFA), which is a part of Structural Equation Modeling (SEM) analysis. If the chi-square value of the CFA was too high, the pointer was corrected by using AMOS statistical software [21]. When the value of the modification index (MI) exceeds 3.84, it indicates that there is a measurement correlation problem between the questions, so the questions with too high a value of MI should be deleted [22]. In this study, question E3 was deleted because it had too high a value of MI, and the rest of the questions were retained.

(1) Validation of Convergent Validity

Convergent validity refers to the average variance extracted (AVE) from the measurement questions corresponding to the latent variables, which reflects their average explanatory power. In this study, all the AVE values were higher than 0.5 [23], as shown in Table 1.

In this study, the higher the internal consistency of the measurement indicators, the stronger the composite reliability in measuring the latent variables, indicating that higher values were more effective in reflecting the construct validity of the latent variables. According to the results of the analysis in this study, the values of the composite reliability of all the dimensions were more than 0.6, which indicated that the model of the study had a good performance in terms of internal quality [23], as shown in Table 1.

(2) Discriminant Validity

In this study, the 95% confidence interval of Bootstrap correlation coefficient was used to detect the correlation coefficient between different dimensions. If the value of confidence interval does not include 1, it indicates that there is discriminant validity between the dimensions [24]. As shown by Table 2, the 95% confidence interval of Bootstrap correlation coefficient was less than 1, so there was discriminant validity between the dimensions of this study.

Table 1. Consolidation of convergent validity and dimension reliability-performance expectancy, effort expectancy, social influence, facilitating condition, level of involvement, and behavioral intention

Question	Standardized loading	Non-dtandardized loading	S.E.	C.R. (t-value)	p	SMC	C.R.	AVE
A1<--- performance expectancy	0.82	1.00				0.68	0.91	0.67
A2<--- performance expectancy	0.80	0.95	0.06	16.48	***	0.63		
A3<--- performance expectancy	0.79	0.95	0.06	15.87	***	0.63		
A4<--- performance expectancy	0.85	1.06	0.06	17.91	***	0.73		
A5<--- performance expectancy	0.84	0.95	0.05	17.64	***	0.71		
B1<---effort expectancy	0.81	1.00				0.66	0.90	0.65
B2<---effort expectancy	0.84	1.06	0.06	17.56	***	0.71		
B3<---effort expectancy	0.82	1.03	0.06	16.69	***	0.67		
B4<---effort expectancy	0.71	1.00	0.07	13.54	***	0.50		
B5<---effort expectancy	0.86	1.04	0.06	17.38	***	0.73		
C1<---social influence	0.70	1.00				0.49	0.91	0.67
C2<---social influence	0.92	1.38	0.09	14.56	***	0.84		
C3<---social influence	0.85	1.27	0.09	13.60	***	0.72		
C4<---social influence	0.86	1.32	0.10	13.82	***	0.74		
C5<---social influence	0.77	1.17	0.09	13.02	***	0.59		
D1<--- facilitating condition	0.77	1.00				0.60	0.91	0.67
D2<--- facilitating condition	0.84	1.16	0.07	15.93	***	0.70		

D3<--- facilitating condition	0.86	1.17	0.07	16.24	***	0.74		
D4<--- facilitating condition	0.88	1.09	0.07	16.78	***	0.77		
D5<--- facilitating condition	0.74	0.92	0.07	13.78	***	0.55		
E1<---level of involvement	0.78	1.00				0.61	0.87	0.64
E2<---level of involvement	0.82	1.12	0.07	15.01	***	0.67		
E4<---level of involvement	0.79	1.06	0.08	14.16	***	0.62		
E5<---level of involvement	0.81	1.07	0.08	14.20	***	0.65		
G1<--- behavioral intention	0.87	1.00				0.76	0.95	0.80
G2<--- behavioral intention	0.91	1.04	0.04	23.57	***	0.83		
G3<--- behavioral intention	0.92	1.06	0.04	23.92	***	0.84		
G4<--- behavioral intention	0.92	1.01	0.04	23.86	***	0.84		
G5<--- behavioral intention	0.87	0.98	0.05	21.59	***	0.76		

Source: Compiled by this study

Table 2. 95% Confidence interval of bootstrap correlation coefficient -UTAUT

Parameter		Estimated value	Bias-corrected		Percentile method	
			Lower limit	Upper limit	Lower limit	Upper limit
Performance expectancy	Effort expectancy	0.75	0.61	0.85	0.61	0.85
Performance expectancy	Social influence	0.59	0.43	0.71	0.45	0.72
Performance expectancy	Facilitating condition	0.66	0.52	0.77	0.53	0.78
Performance expectancy	Behavioral intention	0.70	0.54	0.81	0.56	0.82
Effort expectancy	Social influence	0.50	0.32	0.64	0.33	0.64
Effort expectancy	Facilitating condition	0.73	0.57	0.84	0.58	0.84
Effort expectancy	Behavioral intention	0.64	0.48	0.76	0.49	0.77
Social influence	Facilitating condition	0.68	0.55	0.77	0.56	0.77
Social influence	Behavioral intention	0.76	0.66	0.83	0.67	0.84
Facilitating condition	Behavioral intention	0.86	0.80	0.91	0.80	0.91

Source: Compiled by this study

(3) Structural Model Analysis

In this study, the overall model fit was assessed with seven indexes: $\chi 2$ test, ratio of $\chi 2$ to degrees of freedom, GFI, AGFI, RMSEA, CFI, and PCFI. From the table, it can be seen that the corrected ratio of $\chi 2$ to degrees of freedom was 2.88 (<3), the value of GFI was 0.81 (>0.80), the value of AGFI was 0.80 (>0.80), the value of RMSEA was 0.07 (<0.08), the value of CFI was 0.91 (>0.90), and the value of PCFI was 0.82 (>0.50). Based on the above results, the model of the study was within the acceptable range ([25-26]), as shown in Table 3.

Table 3. Overall fit analysis of research model

Fit index	Allowable criteria	After model correction	Determination of model fit
χ^2 (Chi-square)	The smaller the better	1054.53	Fit
Ratio of $\chi 2$ to degrees of freedom	<3	2.88	Fit
GFI	>0.80	0.81	Fit
AGFI	>0.80	0.80	Fit
RMSEA	<0.08	0.07	Fit
CFI	>0.80	0.91	Fit
PCFI	>0.50	0.82	Fit

Source: Compiled by this study

4.3 Moderating Effect

To analyze the moderating effect of male and female table tennis players in this research model, we set the participant gender as male (n=188) and female (n=123). The results of the moderation analysis (Table 4) showed that there was a significant moderating effect by male and female participants in the causal relationship between social influence and behavioral intention (z-score=-2.12**; $p<0.01$). To analyze the moderating effect of less experienced and more experienced table tennis players in the research model, we set the participant's experience as less experienced (n=263) and more experienced (n=48). The results of moderation analysis showed that there was a significant moderating effect of less experience and more experience in the causal relationship between effort expectancy and behavioral intention (z-score=1.77*; $p<0.05$) and facilitating condition and behavioral intention (z-score=-2.06**; $p<0.01$). In order to analyze the moderating effect of low voluntariness of use and high voluntariness of use of table tennis players in the research model, firstly, we set voluntariness of use as low voluntariness of use (n=125) and high voluntariness of use (n=186). The results of the moderation analyses showed that there was no significant moderating effect in both cases. In order to analyze the moderating effect of low-involvement and high-involvement table tennis players in this model, we set the level of involvement as low-involvement (n=87) and high-involvement (n=224). The results of the moderation analyses showed that there was a significant moderating effect of low involvement and high involvement on the causal relationship between social influence and behavioral intention (z-score=-2.03**; $p<0.01$).

Table 4. Moderating effect analysis

Moderating variable	Causal relationship	Male (βvalue)	Female (βvalue)	z-score
Male and female	behavioral intention<--effort expectancy	-0.16	-0.11	0.34
	behavioral intention<--social influence	0.49	0.22	-2.12**
	behavioral intention<--performance expectancy	0.32	0.28	-0.30
Less experienced and more experienced	behavioral intention<--effort expectancy	-0.23	0.04	1.77*
	behavioral intention<--social influence	0.33	0.54	0.98
	behavioral intention<--facilitating condition	0.59	0.10	-2.06**
Low voluntariness of use and high voluntariness of use	behavioral intention<--effort expectancy	-0.25	-0.05	1.19
	behavioral intention<--social influence	0.29	0.45	1.13
	behavioral intention<--level of involvement	0.13	0.18	0.38
Low-involvement and high-involvement	behavioral intention<--effort expectancy	-0.07	-0.18	-0.71
	behavioral intention<--social influence	0.73	0.33	-2.03**
	behavioral intention<--performance expectancy	0.41	0.25	-1.02

***p<0.001; **p<0.01; *p<0.05

4.4 Test of Research Hypotheses

As shown in Figure 3, H1 was established, that is, the performance expectancy of using smart table tennis bats had a positive and significant effect on behavioral intention. This finding was the same as that of the study conducted by [27]. Table tennis players were more likely to

improve their training outcomes and complete the training sessions after using smart table tennis bats compared to the traditional bats and the traditional training methods. Therefore, the behavioral intention of using smart table tennis bats of table tennis players was also higher.

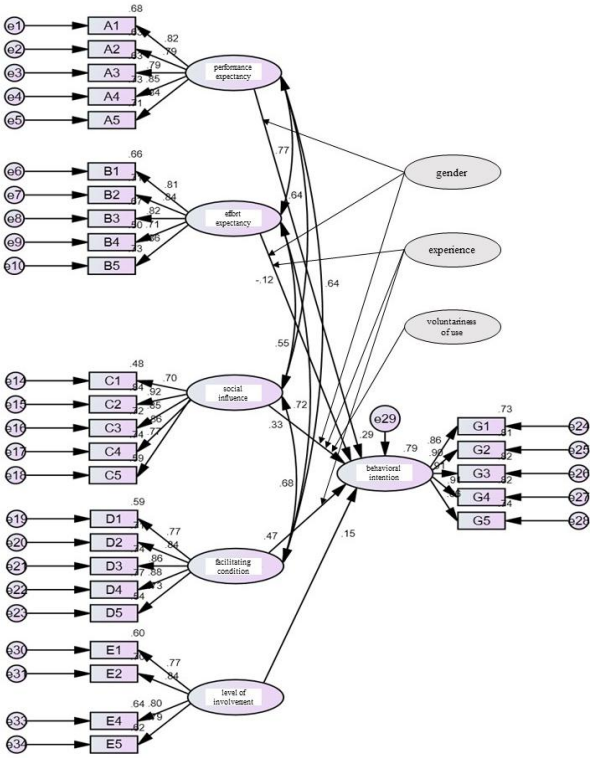

Figure 3. Behavioral patterns of table tennis players

H2 was not established, that is, the effort expectancy of using smart bats failed to have a positive and significant effect on behavioral intention, which is the same as the result of [28]. The possible reason is that the smart bats were gradually being used in the training of table tennis players, and the players and coaches had not yet fully grasped the difficulty in using the bats. The lack of high ease of use resulted in the fact that the behavioral intention of table tennis players to adopt the smart bats was not high.

H3 was established, that is, the social influence of using smart table tennis bats had a positive and significant effect on the behavioral intention, which was the same as the research findings of [29]. It was probably because that the coaches or team members of table tennis player had positive views on the impact of adopting smart table tennis bats on the training. Therefore, the behavioral intention of table tennis players to adopt smart bats was relatively higher.

H4 was established, that is, the facilitating condition of using smart table tennis bats had a positive and significant effect on behavioral intention, and this finding is the same as that of [30]. The possible reason was that table tennis players and team members had a sense of trust in their training and performance after using smart table tennis bats, which in turn improved their behavioral intention.

H5 was established, that is, the level of involvement in using smart table tennis bats had a positive and significant effect on behavioral intention. This finding is the same as that of [31], and the probable reason for this may be that table tennis players had a deeper perception of the importance that the smart table tennis bats played in sports technology and therefore showed concern for smart table tennis bats, which increased the table tennis players' use of smart table tennis bats.

H6 was established, that is, the level of involvement in using smart table tennis bats had a moderating effect on the relationship between social influence and behavioral intention. This finding is the same as [20]. This may be because table tennis players' significant others had already been involved in the use of the smart bat for training and were therefore able to give advice to table tennis players on its use, allowing the level of involvement to have a moderating effect on the relationship between social influence and behavioral intention of using the smart bat.

H7 was not established, that is, the gender of using smart table tennis bats had no moderating effect on the relationship between performance expectancy and behavioral intention. This finding is the same as that of [32]. The possible reason was that smart table tennis bats were often introduced into a table tennis team or a training institution in Taiwan, and male and female table tennis players were exposed to the same sports technology. Therefore, it is possible that gender had no moderating effect between performance expectancy and behavioral intention.

H7-1 was not established, that is, gender of using smart table tennis bats had no moderating effect on the relationship between effort expectancy and behavioral intention, which is different from [33] findings. The possible reason is that different genders had different levels of acceptance of smart table tennis bats, which led to no moderating effect between effort expectancy and behavioral intention.

H8 was established, that is, the experience of using smart table tennis bats had a moderating effect between effort expectancy and behavioral intention. This finding is the same as that of [33]. It was estimated that the possible reason was that table tennis players had been using smart table tennis bats more and more frequently, and they were more able to make use of the big data for the training adjustments, which could lead to a moderating effect between effort expectancy and behavioral intention.

H8-1 was not established, that is, the experience of using smart table tennis bats did not have a moderating effect between social influence and behavioral intention. This finding is the same as [33]. It is possible that this may be due to the fact that table tennis players' experiences of using smart bats may vary across teams or training centers, and significant others in different table tennis teams may have different perceptions of smart table tennis bats. Thus, there was no moderating effect between social influence and behavioral intention.

H8-2 was established, that is, the experience of using smart table tennis bats had a moderating effect on the relationship between facilitating condition and behavioral intention, which is the same as the findings of [33]. The possible reason for this is that as table tennis players

gained more experience in using smart table tennis bats, they had more data to adjust their training. So, experience had a moderating effect on the relationship between facilitating condition and behavioral intention.

H9 was not established, that is, voluntariness of use of smart table tennis bats had no moderating effect between social influence and behavioral intention, which is different from the research finding of [34]. The possible reason is that the adoption of smart table tennis bats by table tennis players was a mandatory requirement, which led to no moderating effect between the social influence and behavioral intention by voluntariness of use of smart table tennis bats.

5 Conclusions

From the results of this study, Except for H2, H7, H7-1, H8-1 and H9, which were not established, the rest of the research hypotheses were all established. The conclusions of this study are similar to the results of most related studies, indicating that the UTAUT is suitable for observing the adoption of today's consumer technology. At the same time, there are more specific research results on the acceptance of table tennis players using smart table tennis bats.

6 Suggestions

(1) For Table Tennis Players

The results of this study showed that the performance expectancy of smart table tennis bats had a positive and significant effect on the behavioral intention, which is identical to the research results of [27]. Therefore, it is suggested that table tennis players need to have a certain degree of understanding of the operation, principle and application of smart table tennis bats. As people said, if you want to do good work, you must sharpen your tools first. Table tennis players should have a basic ability to interpret the physiological values provided by smart table tennis bats as well as the technical information such as the stance, ball speed or landing point. Then, it will increase the likelihood of their understanding of the degree of integration of the smart bats with training, which in turn will enhance their extrinsic motivation and perceived usefulness of using the smart bats to improve the performance of the game and training. This will thus increase their behavioral intention to use the smart bats. In addition, the results of this study indicated that the facilitating condition for using smart table tennis bats had a positive and significant effect on the behavioral intention, and [30] also proposed a similar argument. In other words, to improve the behavioral intention of table tennis players, it is recommended that table tennis players study whether the smart table tennis bats are in line with their own habits of using them. For example, apart from the relevant circuits of the smart table tennis bats, the most important part of the smart table tennis bats is the lithium battery that provides the electricity. However, the lithium battery not only increases the overall weight of the bat, but also affects the feel of the bat. So, it is very important to adapt or adjust. Moreover, it is suggested that table tennis players should judge their compatibility with the smart bat in terms of their training needs and past experiences in competitions and training, as they will be more willing to adopt the smart bat only after the compatibility is improved. On the other hand, the results of this paper showed that the level of involvement in using smart table tennis bats had a positive and significant effect on the behavioral intention, and a similar argument was raised by the study of [31]. Therefore, it is recommended that table tennis players not only have a deep understanding of smart table tennis bats, but also grasp the chance of the development of sports science and technology in Taiwan. For example, after the launch of the "Precision Sports Science Research Project Program" in Taiwan, how to connect the energy of industry, government and academia to explore the development of new technologies and assist the top athletes in training with sports technology is of great importance to table tennis players' competition and training. Therefore, increasing the involvement of smart table tennis bats will help table tennis players grasp the pulse of sports technology information, and enhance the behavioral intention of using the smart table tennis bat while recognizing the importance of the product.

(2) For Organizations Related to Research and Development of Smart Table Tennis Bats

The results of this study showed that the social influence of using smart table tennis bats had a positive and significant effect on behavioral intention, while [29] once had the same argument. Therefore, it is suggested that the organizations related to the research and development of smart table tennis bats should provide educational training programs on smart table tennis bat products to the significant others of table tennis players, such as coaches and the people of training centers. For example, in a precision sports science research project hosted by the National Taiwan University of Sport, a 9-axis sensor was embedded in the wooden grip of the bat, and a thin FSR (Force Sensitive Resistor) pressure sensor board was glued in the middle layer of the wooden board and rubber. This enabled excellent players to experience the recording of important data for each shot when hitting the ball, and obtain the player's parameters of swing force, speed, acceleration and trajectory, and hitting point. However, for coaches who have been using traditional training methods for a long time, it seems that sports technology is not something they can familiarize with in a short time. Therefore, it is suggested that the research and development organizations of smart table tennis bats should provide relevant seminars or workshops to pass the product information or the latest application of smart table tennis bats to the coaching staff of the table tennis teams. Since the coach is one of the most important people having influences on the table tennis player, if the significant others of the table tennis player can be informed of how the smart table tennis rat captures the player's information and analyzes the data to show the effectiveness of the training, it will help the table tennis player to improve the behavioral intention of using the

smart bat. On the other hand, with the advancement of internet technology, social media is becoming an important aspect of social influence. Therefore, it is suggested that the research and development organizations of smart table tennis bats should move towards the socialization of sports. Especially, different ecosystems have been formed by social biographies. If the research and development organizations of smart table tennis bats can invite table tennis star players to link up with the vast urban table tennis community network, it will help to influence to a certain extent the behavioral intention of table tennis players' using smart table tennis bats. Besides, the results of this study indicated that the facilitating condition of using smart table tennis bats had a positive and significant effect on the behavioral intention, which was like the viewpoint of [33]. Therefore, it is suggested that research and development organizations of smart table tennis bats should reduce the limitations and discomforts of using the smart table tennis bats by table tennis players in the development of smart table tennis bats in the future. For example, the difference in bat weight caused by the lithium battery embedded in the bats mentioned above may affect swing speed, which may reduce players' behavioral intention if they perceive this slight weight difference as a disadvantage. Therefore, details such as the design of smart bats should be addressed first by the research and development organizations of smart table tennis bats. Finally, ease of use is a key factor in the acceptance of a new technology. As mentioned above, with the popularization of sports technology, it is suggested that the development of information systems should provide humanized solutions, and the development of smart bats that are easy to operate and learn will help to increase the motivation of table tennis players or enthusiasts to learn about smart bats, which will demonstrate their usefulness and promote positive attitudes towards their use.

(3) Suggestions for Future Research

The questionnaire method adopted by this study may not be able to present a complete picture of the actual experience of table tennis players in using smart table tennis bats. Therefore, it is suggested that future research may conduct more in-depth interviews with table tennis players using smart table tennis bats and be supplemented with more in-depth field observation to understand the insight of table tennis players using smart table tennis bats on the topic of the study. This will help to construct the researcher's perception of table tennis players' use of smart bats, and help to broaden the researcher's perspective of study. In other words, the use of both quantitative statistical analysis and qualitative research methods to further explore table tennis players' behavioral intention of using smart table tennis bats will help to enhance the value of the study.

In terms of the research area, this paper only explored the factors affecting table tennis players' use of smart table tennis bats, i.e., the effects of performance expectancy, effort expectancy, social influence, facilitating condition, and level of involvement on the behavioral intention. But this study failed to examine the factors that really affected the real behavior. Therefore, it is recommended that future research should track the use of smart table tennis bats by table tennis players in the long term, so that more detailed results can be provided on the factors affecting the use of smart table tennis bats by table tennis players. In addition, this study found that the experience of using smart table tennis bats had a moderating effect on the relationship between facilitating condition and behavioral intention, which was investigated by using table tennis players as the research subjects. However, with the popularization of sports technology, it is expected that relevant technology will be widely used by the public in the future. It is worthwhile to further analyze whether the difference in the experience of using smart table tennis bats will have the same moderating effect on the public pursuing casual leisure.

(4) Research Limitations

As to the limitation of this paper, as the development of smart table tennis bats is becoming more and more diversified, different brands have different systems and operating interfaces with their own advantages and disadvantages. The individual's habit of using smart table tennis bats may be affected using different brands of smart table tennis bats, which makes table tennis players fill out the questionnaire in a different context from the smart table tennis bats they are using, and this will cause the results of the study to be affected. It is suggested that the future researchers should choose the smart table tennis bats with representative influence for study.

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