

Article

# Exploring the impact factors of the usage intention of AR sports games for home exercise based on the decomposed theory of planned behavior

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**Abstract:** This study aims to explore the factors influencing people's intention to use home fitness mobile apps in the post-pandemic era. By incorporating the perspective of playfulness into the decomposed theory of planned behavior, it seeks to construct a behavioral model for the public's use of AR sports games for home exercise. The research focuses on Active Arcade users residing in Taiwan, employing the snowball sampling method to conduct an online questionnaire survey. A total of 340 valid questionnaires were collected and analyzed using linear structural equations. The study reveals three main findings: first, the behavioral model for Active Arcade users constructed based on the decomposed theory of planned behavior demonstrates a good fit; second, users' attitudes, subjective norms, and perceived behavioral control have a positive and significant impact on behavioral intention; third, perceived usefulness, perceived ease of use, and perceived playfulness all positively and significantly influence attitudes, with perceived playfulness having the highest impact coefficient; fourth, perceived benefits of exercise are the most crucial factor affecting subjective norms; and fifth, convenience technologies are the key factor influencing perceived behavioral control. This study provides valuable insights for theory and management practice, offering guidance on the use of home fitness apps in the post-pandemic era while addressing research limitations and suggesting future directions.

**Keywords:** post-pandemic era; perceived playfulness; health belief model; decomposed theory of planned behavior; home fitness apps

## 1. Introduction

### 1.1. Background

Wearable devices come in various forms and serve multiple healthcare functions, both in the workplace and daily life. They provide convenience, real-time monitoring, and intelligent features for physiological and motion detection (Liu et al., 2021). These devices collect and analyze personal data to monitor the health of the wearer (Smith et al., 2023). According to a recent report from App Annie, a mobile market data platform in the United States, the global spread of the epidemic has significantly altered people's living habits, particularly increasing their reliance on mobile phones (Kristianto, 2020).

The COVID-19 pandemic has posed a severe challenge to human society, with the number of cases worldwide reaching 500 million and resulting in 6.19 million deaths (WHO, 2023). As one of the deadliest epidemics in history, COVID-19 has disrupted societies, economies, and individual lives, while also challenging national governance (Cingolani, 2023). Furthermore, it has placed additional stress on global mental health. In response, governments implemented various epidemic prevention strategies, such as maintaining social distance, closing schools, and promoting home isolation, which were effective in slowing the virus's spread (Lau et al., 2020).

We as researchers have tracked the impact of the epidemic on various industries, and we have found that during the epidemic, people were more inclined to use mobile phones than ever before. According to Grand View Research, the global mobile health application market reached USD 12.4 million dollars and will grow to 44.7% in the period of 2019–2026 (Grand View Research, 2019; Yin et al., 2021). In fact, from April to June of 2020, the time people spent on mobile applications increased by 40% every month and even exceeded a record high of 200 billion hours in April (Kristianto, 2020). Sports and health information platforms have emerged continuously and the users of sports and health platforms have been monitored by the online technologies (Lee et al., 2021). Therefore, to achieve the goals of the national home movement, utilizing the Internet and digital audiovisual media is both inevitable and the most convenient approach.

Although the epidemic has dealt a severe blow to the fitness and sports industry, it has also brought about new business opportunities (Chang et al., 2020). During the COVID-19 pandemic, only 26% of people worldwide managed to maintain their fitness habits; however, in Taiwan, this figure rose to 51%. This difference may be attributed to the Taiwanese government's proactive epidemic prevention measures and the public's cooperation, which minimized the impact on fitness activities (Chang et al., 2020). As people increasingly value their experiences and perceptions when using smartphones (Lin et al., 2022), there is a growing interest in integrating information technology into community development.

Governments and organizations worldwide are incorporating information technology into urban development plans to address modern challenges. The COVID-19 pandemic has highlighted the role of technology in transforming fitness habits and urban living, emphasizing its importance in building smart cities. Individuals can use the Internet, cloud technology, and the Internet of Things to maintain or improve their exercise routines through new media platforms. At the same time, governments can promote the collection of sports data by encouraging the use of wearable devices, developing sports data platforms, and collaborating with tech companies to enable data sharing. These efforts help individuals track their exercise in real time and receive personalized recommendations, supporting overall public health initiatives.

## **1.2. Theory**

In order to contribute to the sustainable development of health and fitness, this study is based on the argument of health beliefs that was first proposed by social psychologists in 1950 and mainly explored the public's participation in public health screening services (Hochbaum, 1958). The health belief model (HBM) is composed

of perceived susceptibility, perceived severity, perceived threat of disease, perceived benefits of action, perceived barriers to action, and cues to action. Perceived exercise benefits (PEB) refer to the individual's subjective evaluation of the benefits of their own health behaviors, which conforms to the individual's own cognition and beliefs and decides to adopt healthy behavior tendencies (Rosenstock, 1966).

With the widespread administration of COVID-19 vaccines, humanity begins to coexist with the pandemic. As a result, in this post-pandemic era, people worldwide are living under the threat of the epidemic, and their lives have been affected by numerous restrictions. The World Health Organization (WHO) also indicated that staying indoors for a long time will have a negative impact on the human body and mind (WHO, 2022). A lot of reports in the news media stated that people needed to maintain the habit of exercising even more under the epidemic (Villines, 2020). However, living under the epidemic and the exaggeration of the news and online media, people may be regulated by external information on their own health and thus change their behavior (Bechard et al., 2020; Jose et al., 2021; Yang et al., 2022). In order to understand whether people will regulate their own health status from news media at home, perceived exercise benefits is used as the measurement dimension of external influence.

Active Arcade App was launched by Next Team Inc (2017) and released on the Google Play Store in 2021. The design of Active Arcade uses advanced full-body motion tracking powered by AI, combined with gamification and augmented reality (AR) to make the experience fun for everyone. The camera will digitize your movements and power the gameplay in real-time. Since its release, there have been as many as 12 different types of games, and the levels of the games have also been continuously updated, and the types of game are diverse from jumping and kicking to dodging. Due to the diversity of game types, users will need to engage various muscle groups throughout the gaming process, thus achieving training effects. In addition, two people playing games together is an interesting feature of Active Arcade. The game is designed to be completed by two people together, two-player battles, etc. Besides playing alone, players can also play games with family and friends. Active Arcade is a new digital playground that you can play in anytime, anywhere, with anyone.

With the emergence of numerous cross-field integrations and the advancement of technology, human behavior will be changed due to more factors, making it more complicated. The theory of planned behavior (TPB) was proposed by Ajzen (1985). The basic framework of TPB evolved from the theory of reasoned action (TRA), mainly used to understand and predict the behavior of individuals, proposed by Fishbein and Ajzen (1977). The TPB is determined by behavioral intention and maintains three core components, namely attitude towards a behavior, subjective norm, and perceived behavior control.

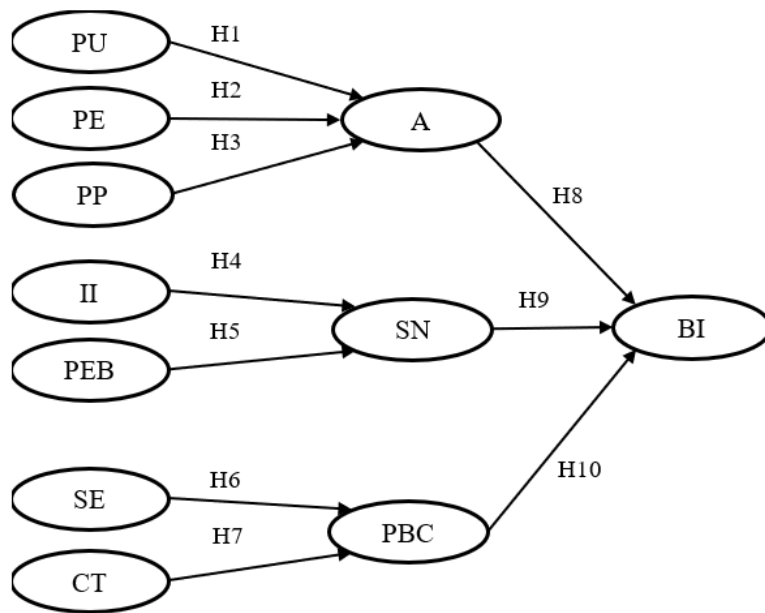
Compared with the TRA, the TPB is considered to be a relatively complete model of behavioral intention, which can better predict the behavior of human society and make up for the limitation that the TRA cannot measure individual behavior under incomplete volitional control; therefore, it has been highly valued by scholars and widely used in research in various fields such as Apple Watch wearable devices (Lin et al., 2019), online banking (Shih and Fang, 2004), organic commodity consumption

behavior (Tsai et al., 2015), etc., and is used as the main theory to explore a specific behavior of individuals.

The traditional TPB or TRA theory does not consider the impact mechanism of this new form and the explanation for the people who use home fitness apps is no longer enough. At the same time, research on perceived playfulness in corporate applications has found that perceived playfulness positively influences users' subsequent behavioral intentions (Lin et al., 2022). Therefore, this study will use the decomposed theory of planned behavior (DTPB) as the main basis to explore the people's use behavior of home fitness apps.

The DTPB, founded by Taylor and Todd (1995), is based on the TPB and is extended by adding the characteristic of technology acceptance models (TAMs) by Davis et al. (1989) diffusion of innovations by Rogers and Williams (1983), and perceived playfulness proposed by Moon and Kim (2001) to another theoretical model, which replaces the one-way TPB with a multi-faceted belief framework. The DTPB retains all the variables of the TPB and also has TAM variables that are suitable for exploring factors affecting information technology. Combining these two theories, it makes up for the shortcomings of the TPB and TAM. Therefore, the DTPB is the main theoretical model to explore the use intention in fitness mobile app.

According to the previous literature review, we proposed the conceptual framework and hypotheses as shown in **Figure 1**.



**Figure 1.** Conceptual framework and hypotheses.

Notes: Perceived usefulness (PU); perceived ease of use (PE); perceived playfulness (PP); interpersonal influence (II); perceived exercise benefits (PEB); self-efficacy (SE); convenience technologies (CT); attitude(A); subjective norm (SN); perceive behavioral control (PBC); behavior intention (BI).

- H1: Perceived usefulness has a significant positive effect on attitude.
- H2: Perceived ease of use has a significant positive effect on attitude.
- H3: Perceived playfulness has a significant positive effect on attitude.
- H4: Interpersonal influence has a significant positive effect on subjective norm.
- H5: Perceived exercise benefit has a significant positive effect on subjective norm.
- H6: Self-efficacy has a significant positive effect on perceived behavioral control.

H7: Convenience technologies have a significant positive effect on perceived behavioral control.

H8: Active Arcade App users' attitude has a significant positive effect on behavior intention.

H9: Active Arcade App users' subjective norm has a significant positive effect on behavior intention.

H10: Active Arcade App users' perceived behavioral control of has a significant effect on behavioral intention.

## **2. Materials and methods**

### **2.1. Research objects and data collection**

This study mainly focuses on the influencing factors of intention to use Active Arcade App during the epidemic period. We collected online questionnaires in Taiwan during the post-pandemic era and conducted surveys targeting Active Arcade App users. During the period of questionnaire collection, Taiwan was under lockdown, and many activities were restricted, including going out to collect questionnaires. According to Atkinson and Flint (2001), using the snowball sampling method can help reach participants who are difficult to directly access.

During the process of distributing the questionnaire, discussions and posts were initiated in the aforementioned Facebook fan pages and forums related to Active Arcade, inviting relevant users to assist in completing the questionnaire. Additionally, we sent the online questionnaire via private messages on Facebook to active members (those posting or replying to comments) in the Active Arcade Taiwan fan club. The questionnaires were collected voluntarily from the recipients. We also asked Active Arcade users to forward the questionnaire to their family and friends who use Active Arcade.

The users who have used the Active Arcade App were chosen as the research objects, and the snowball sampling method was employed to conduct the online questionnaire survey. The survey questionnaires were all filled out anonymously to protect the personal privacy of the respondents. The questionnaires were issued from 15 November 2021 to 15 January 2022. A total of 350 questionnaires were returned. After a thorough data screening process, invalid samples, such as those with uniform answers throughout, extremely short response times, or evident patterned responses suggesting a lack of genuine engagement, were excluded to enhance the reliability and validity of the data. Consequently, 340 valid questionnaires were retained, yielding an effective return rate of 97.14%.

### **2.2. Analysis methods**

A five-point Likert scale was used in this study. The measurement items of perceived usefulness (PU) and perceived ease of use (PE) mainly refer to Taylor and Todd (1995), and the measurement method refers to Wu and Jiang (2014). The measurement items of perceived playfulness (PP) refer to Moon and Kim (2001), and the measurement method refers to Chen (2012), and Lin et al. (2019). The measurement items of interpersonal influence (II) and perceived exercise benefits

(PEB) refer to Bhattacharjee (2000), and the measurement method refers to Hsiao (2015). The measurement items of self-efficacy (SE) and convenience technologies (CT) refer to Taylor and Todd (1995), and the measurement method refers to Chen (2012), and Lin et al. (2019). The measurement items of attitude (A), subjective norm (SN), perceived behavioral control (PBC), and behavior intention (BI) refer to Bhattacharjee (2000), and the measurement method refers to Wu and Jiang (2014), and Lin et al. (2019). The total number of questions in the questionnaire is 55.

### **2.3. Data analysis for validity and reliability**

Further inspection of the factor loadings of each item in the overall Active Arcade found items perceived exercise benefits (PEB) 3, 4 and behavioral intention 1, although their latent factor loadings reached ( $<0.50$ ) affected the model fit; therefore, these questions were deleted. After the deletion, the fit of Active Arcade App's verification factors mostly reached the good test standard.

According to West et al. (1995), the standard of skewness of each variable must be less than 2, and the kurtosis should not be greater than 7. The analysis results show that the mean of observed variables in this study was between 3.25 and 4.34, the standard deviation was between 0.726 and 1.247, the skewness value was between  $-0.686$  and  $-8.38$ , and the kurtosis value was between  $-3.83$  and 4.74. The data met the normality test standard.

According to the confirmatory factor analysis (CFA), in the convergent validity of the overall scale of the Active Arcade App, the factor loadings were above 0.50, and the factor loadings of the perceived usefulness (PU) were between 0.740 and 0.780; the factor loadings of perceived ease of use (PE) were between 0.760 and 0.820; the factor loadings of perceived playfulness (PP) were between 0.810 and 0.840; the factor loadings of attitude were between 0.630 and 0.770; the factor loading of interpersonal influence (II) was between 0.710 and 0.840, the factor loading of perceived exercise benefits (PEB) was between 0.750 and 0.860; the factor loading of subjective norm (SN) was between 0.620 and 0.920; the factor loadings of self-efficacy were between 0.780 and 0.840; the factor loadings of technological convenience ranged from 0.780 to 0.840; the factor loadings of convenience technologies (CT) ranged from 0.680 to 0.820; the factor loadings of perceived behavioral control (PBC) ranged from 0.660 to 0.740; and the factor loadings of behavioral intention (BI) were between 0.680 and 0.780. Therefore, there was no need to delete questions based on this indicator. In addition, in the reliability measurement of the overall scale of the Active Arcade App, the item reliability ranged from 0.384 to 0.846; the composite reliability (C.R.) of each variable was 0.850, 0.875, 0.895, 0.776, 0.864, 0.847, 0.897, 0.877, 0.867, 0.789, and 0.788; and the average variance extracted (AVE) of each variable was 0.586, 0.637, 0.681, 0.488, 0.616, 0.582, 0.691, 0.641, 0.568, 0.485, and 0.554, as shown in **Table 1**.

According to Hair et al. (2021) the standard composition reliability (C.R.) must be above 0.7; in addition, according to Fornell and Larcker (1981), the standard value of AVE should be greater than 0.5. After the analysis of this scale, all the values obtained reach the standard from the above. It can be extrapolated that the overall scale of the Active Arcade App in this study has good reliability and validity.

**Table 1.** Confirmatory factor analysis (CFA).

<b>Variables</b>	<b>Items</b>	<b>Factor loading</b>	<b>Item reliability</b>	<b>C.R.</b>	<b>AVE</b>
Perceived usefulness (PU)	I think that using Active Arcade would be enough for my exercise needs.	0.780	0.608	0.850	0.586
	I think using Active Arcade can increase my exercise frequency.	0.780	0.608		
	I think that using Active Arcade will boost my chances of getting exercise.	0.760	0.578		
	Overall, I think using Active Arcade is helpful for my exercise.	0.740	0.548		
Perceived ease of use (PE)	I think the interface of Active Arcade is easy.	0.800	0.640	0.875	0.637
	I think Active Arcade games are easy to play.	0.810	0.656		
	I don't think learning to use Active Arcade is too difficult.	0.760	0.578		
	Overall, I think the operation of Active Arcade is simple.	0.820	0.672		
Perceived playfulness (PP)	I think I am having fun with Active Arcade.	0.810	0.656	0.895	0.681
	I think using Active Arcade will satisfy my entertainment needs.	0.830	0.689		
	I think I've had a lot of fun with Active Arcade.	0.840	0.706		
	I think Active Arcade puts me in a good mood when I use it.	0.820	0.672		
Attitude (A)	I think it is meaning fullness to use Active Arcade.	0.630	0.397	0.776	0.488
	I think Active Arcade is useful.	0.630	0.397		
	My assessment of Active Arcade is positive.	0.750	0.563		
	I think using Active Arcade is a pleasant experience.	0.770	0.593		
Interpersonal influence (II)	I think positive comments from family and friends about Active Arcade are important.	0.840	0.706	0.864	0.616
	I think it's important that family and friends have a good experience with Active Arcade.	0.830	0.689		
	I think it is important to use Active Arcade with my family and friends.	0.710	0.504		
	I think it is important for my family and friends to support me to use Active Arcade.	0.750	0.563		
Perceived exercise benefits (PEB)	I think exercise with Active Arcade can increase physical activity.	0.750	0.563	0.847	0.582
	I think that using Active Arcade exercise can maintain my physical fitness.	0.750	0.563		
	I think exercising with Active Arcade can boost my body immunity.	0.860	0.740		
	I think using Active Arcade sports can reduce the chances of getting COVID-19.	0.680	0.462		
Subjective norm (SN)	I use Active Arcade because of the trend.	0.620	0.384	0.897	0.691
	People who are important to me think that I should use Active Arcade.	0.850	0.723		
	I gain approval from family and friends by using Active Arcade.	0.920	0.846		
	People who have influenced in my life think I should use Active Arcade.	0.900	0.810		

**Table 1.** (Continued).

Variables	Items	Factor loading	Item reliability	C.R.	AVE
Self-efficacy (SE)	I think I'm capable of operating Active Arcade.	0.800	0.640	0.877	0.641
	Even without teaching, I can carry out game contents and operations smoothly.	0.780	0.608		
	I can operate the Active Arcade and start exercising by myself.	0.840	0.706		
	I'm very comfortable with Active Arcade.	0.780	0.608		
Convenience technologies (CT)	I think the operation pages of Active Arcade are smooth.	0.820	0.672	0.867	0.568
	I think the functionality provided by Active Arcade is useful.	0.800	0.640		
	I think my smartphone has what it takes to operate Active Arcade.	0.750	0.563		
	I think my smartphone has what it takes to operate Active Arcade (network, space).	0.710	0.504		
	I can freely and conveniently use Active Arcade at home.	0.680	0.462		
Perceive behavioral control (PBC)	I think that operating Active Arcade is within my control.	0.740	0.548	0.789	0.485
	I think operating Active Arcade is smooth.	0.720	0.518		
	I think what I want to do can be done with Active Arcade.	0.660	0.436		
	I think I have enough resources (time, knowledge) to use Active Arcade.	0.660	0.436		
Behavior intention (BI)	I will use Active Arcade with my family and friends.	0.770	0.593	0.788	0.554
	I would recommend Active Arcade to others.	0.780	0.608		
	I will share Active Arcade information on social media.	0.680	0.462		

#### 2.4. Discriminant validity analysis

This study mainly used the confidence interval method to test the discriminant validity of the overall behavior model. According to Torkzadeh et al. (2003), if the confidence interval method is used for testing, the confidence interval does not contain 1, and that is complete correlation, indicating that the facets have discriminant validity. In this study, repeated estimates (2000 times) were carried out using the bootstrap method, and the confidence level was below 95%. It was measured by the estimation methods of the error correction and the percentile. This study explored the intention of use of Active Arcade App during the epidemic with the decomposed theory of planned behavior (DTPB). The upper bounds of the confidence interval of each variable did not contain 1, indicating that there was no correlation between the behavior model dimension; therefore, each variable had discriminant validity.

#### 2.5. Data analysis

In this study, SPSS and AMOS statistical software were used for various statistics and analysis. The analytical methods included descriptive statistics, confirmatory factor analysis (CFA), structural equation model (SEM), and various statistical tests; the significance level is  $\alpha = 0.05$ .

SEM was used because it can simultaneously examine the relationships between multiple dependent and independent variables, making it highly suitable for analyzing multivariate models. The fit of Active Arcade App's verification factors confirmatory



factor analysis (CFA) was the goodness of fit index (GFI) and the (adjusted) goodness of fit (AGFI) in the absolute fit index; the normed fit index (NFI), relative fit index (RFI), incremental fit index (IFI), Tucker–Lewis index (TLI) and comparative fit index (CFI) in value added fitness. None of the CN values in the parsimonious fit indicators met the standard, indicating that the original Active Arcade confirmatory factor model needed to be revised.

### **3. Results**

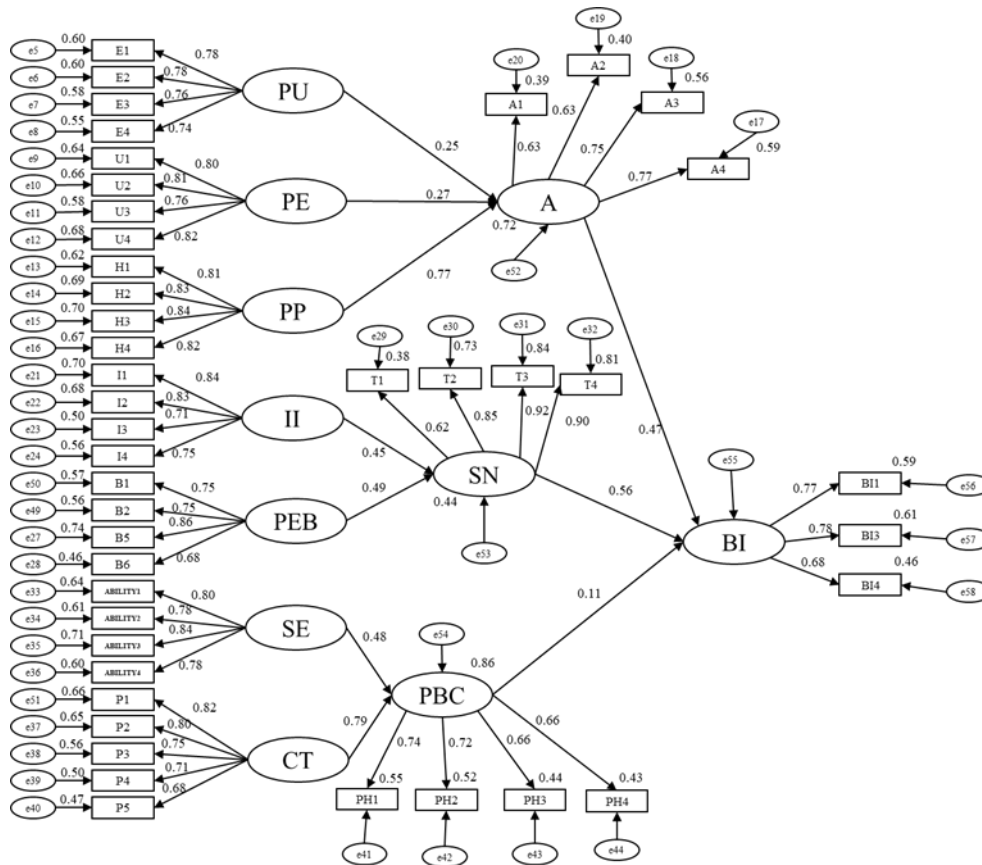
In this study, males accounted for 29.4% and females accounted for 70.6% of subjects; most of the age groups were in the age range of 21–30, 52.6%; education mainly was in universities/colleges, 71.5%; occupations mainly were students, 47.6%; monthly income below TWD 20,000 accounted for 44.4%; 69.7% of the subjects exercised regularly; the average of using the app one time per week accounted for 67.4%; and 41.2% of the subjects knew the apps through friends and relatives.

#### **Confirmatory factor analysis (CFA)**

The analysis of the results shows that the average of observable variables was between 3.25 and 4.34; the standard deviation was between 0.73 and 1.25; the skewness value was between  $-0.84$  and  $-0.69$ ; and the kurtosis value was between  $-3.83$  and  $4.74$ . All the data conform to the standard of normality test (Torkzadeh et al., 2003).

In the normality test of this study, it was found that although the sample data met the single variable normality, the C.R. value of multivariate kurtosis was 98.232, which did not meet the multivariate normal distribution. Therefore, the bootstrap method by Bollen and Stine (1992) was used for modification. In the overall behavior pattern fit, RMSEA = 0.012, GIF = 0.923, AGIF = 0.913, NFI = 0.923, RFI = 0.918, IFI = 0.996, TLI = 0.996, CFI = 0.996, CN = 323.587, and  $\chi^2/DF = 1.051$ . It was found that the detection values of the overall behavior pattern reached the standard. In the goodness of fit of overall behavior model, RMSEA = 0.012, GIF = 0.923, AGIF = 0.913, NFI = 0.923, RFI = 0.918, IFI = 0.996, TLI = 0.996, CFI = 0.996, CN = 323.587,  $\chi^2/DF = 1.051$ , found that the detection values of the overall behavior model reach the standard.

As **Figure 2** shows, perceived usefulness, perceived ease of use, and perceived playfulness have positive effects on attitudes, among which perceived playfulness, 0.77, had the greatest impact, indicating that perceived playfulness is the key factor affecting attitudes. Interpersonal influence and perceived exercise benefits had positive effects on subjective norms, and perceived exercise benefits, 0.49, had the greatest impact, indicating that the impact of external information received by people indirectly affects their subjective norms. Self-efficacy and convenience technologies had positive effects on perceived behavioral control, and convenience technologies, 0.79, had the greatest impact, indicating that app users' control over technology will affect perceived behavioral control; attitude, subjective norm, and perceived behavioral control had a positive impact on behavioral intention, among which subjective norm had the greatest impact, indicating that the epidemic indirectly affected people's final behavioral intentions.



**Figure 2.** The pattern path diagram of active arcade app user behavior.

Notes: PU: perceived usefulness; PE: perceived ease of use; PP: perceived playfulness; II: interpersonal influence; PEB: perceived exercise benefits; SE: self-efficacy; CT: convenience technologies; A: attitude; SN: subjective norm; PBC: perceived behavioral control; BI: behavior intention.

**Table 2.** Confirmatory factor analysis (CFA).

Hypothesis	Effects	Estimate	<i>t</i>	<i>p</i>	Remarks
H1	PU→A	0.25	3.656 *	0.000	Support
H2	PE→A	0.25	4.816 *	0.000	Support
H3	PP→A	0.77	1.153 *	0.000	Support
H4	II→SN	0.45	6.660 *	0.000	Support
H5	PEB→SN	0.49	6.817 *	0.000	Support
H6	SE→PBC	0.48	5.994 *	0.000	Support
H7	CT→PBC	0.79	9.268 *	0.000	Support
H8	A→BI	0.47	7.129 *	0.000	Support
H9	SN→BI	0.56	8.471 *	0.000	Support
H10	PBC→BI	0.11	2.101 *	0.036	Support

Notes: Note: \*  $p < 0.05$ . PU: Perceived usefulness; PE: Perceived ease of use; PP: Perceived playfulness; II: Interpersonal influence; PEB: Perceived exercise benefits; SE: Self-efficacy; CT: Convenience technologies; A: Attitude; SN: Subjective norm; PBC: Perceived behavioral control; BI: Behavior intention

The results, as shown in **Table 2**, demonstrate the significance of various factors influencing behavioral intentions in the context of the Active Arcade App. Specifically, the standardized coefficient of perceived usefulness on attitude was 0.25, with a *t*-value of 3.656. Similarly, H2 was established as the standardized coefficient of

perceived ease of use on attitude was 0.25, and the  $t$ -value was 4.816. For perceived playfulness on attitude, the standardized coefficient was 0.77, with a  $t$ -value of 1.153, indicating significance and thus supporting H3.

H4 was supported, with a standardized coefficient of interpersonal influence on subjective norm at 0.45 and a  $t$ -value of 6.660. Likewise, H5 was supported, as the standardized coefficient of perceived exercise benefits on subjective norm was 0.49 with a  $t$ -value of 6.817. Additionally, the standardized coefficient of self-efficacy on perceived behavioral control was 0.48, with a  $t$ -value of 5.994, thus supporting H6.

In terms of convenience technologies on perceived behavioral control, the standardized coefficient was 0.79 with a  $t$ -value of 9.268, supporting H7. For attitude on behavioral intention, H8 was supported, as the standardized coefficient was 0.47 with a  $t$ -value of 7.129.

Subjective norm on behavioral intention was confirmed with a standardized coefficient of 0.56 and a  $t$ -value of 8.471, supporting H9. Lastly, H10 was supported, with the standardized coefficient of perceived behavioral control on behavioral intention at 0.11 and a  $t$ -value of 2.101.

## **4. Discussion**

### **4.1. The overall model of active arcade app users has a good fit**

The decomposed theory of planned behavior (DTPB) is used in this study to explore the influencing factors of Active Arcade App users to use the app; Moon and Kim's research (2001) and the health belief model (HBM) were also adopted, adding the influencing factors of perceived playfulness and perceived exercise benefits to the model. The results show that overall behavior pattern of App users has a good fit, indicating that the results of the study are acceptable patterns. In addition, all variables in this study had good explanatory power; among them, the  $R^2$  of attitude was 0.72; in the attitude dimension, perceived playfulness had the greatest influence on attitude, and  $R^2$  was 0.77;  $R^2$  of subjective norm was 0.44; in the subjective norm dimension, perceived exercise benefits had the greatest influence on subjective norms, and  $R^2$  was 0.49.  $R^2$  of perceived behavioral control was 0.86; in the perceived behavioral control dimension,  $R^2$  self-efficacy to perceived behavioral control was 0.79, and its explanatory power was the best. In the framework of the theory of planned behavior,  $R^2$  of attitude, subjective norm, and perceived behavior control to behavioral intention was 0.56. The explanatory powers of each dimension and subdimension were more than 30%. In view of the above, the perceived exercise benefits (PEB) of the technology acceptance models (TAMs) and health belief model (HBM) can be effectively used to explore the influencing factors of Active Arcade App users.

### **4.2. Perceived usefulness, perceived ease of use, and perceived playfulness have positive and significant effects on attitude**

This study revealed several key findings regarding users' attitudes towards the Active Arcade App. Firstly, users perceived the app as a useful tool for exercise initiation, which contributed to an increased frequency of physical activity. This positive perceived usefulness significantly impacted users' attitudes. Secondly, users

found the app easy to navigate and interact with, both in terms of its operation pages and game levels. This perceived ease of use fostered a positive evaluation of the app and consequently influenced users' attitudes positively. Lastly, users associated exercising with the Active Arcade App with enjoyment and amusement, enhancing their overall exercise experience and potentially prolonging exercise sessions. Perceived playfulness emerged as a significant factor in shaping users' attitudes towards the app. Together, these findings underscore the importance of perceived usefulness, ease of use, and playfulness in shaping users' attitudes towards utilizing the Active Arcade App for exercise. The findings of this study align with previous research on mobile learning in higher education (Jawad and Hassan, 2015), M-commerce Adoption in India (Gangwal and Bansal, 2016), mobile banking (Munoz et al., 2017), smart watch (Lin et al., 2019), nike+ run club app (Lin et al., 2020) and duty-free shop user behavior (Choi and Park, 2020).

### **4.3. Interpersonal influence and perceived exercise benefits have a significant positive effect on subjective norm**

In this study, both interpersonal influence and perceived exercise benefits significantly impacted subjective norm, with exercise benefits having a greater influence. Users prioritized engagement with the Active Arcade App alongside family and friends, valuing their experiences with the app. As users often used the app in shared spaces, they were influenced by the opinions and behaviors of their social circle. Consequently, interpersonal influence emerged as a significant factor shaping subjective norm. Additionally, users were influenced by information shared within the online community or through third-party promotions, shaping their perception of using the Active Arcade App for exercise. This highlights the substantial positive impact of perceived exercise benefits on subjective norm (Gelaidan et al., 2023). This result is consistent with the findings of Choi and Park (2020), Lin et al. (2020), Lin et al. (2022) and the integrate digital literacy by Sadaf and Gezer (2020).

### **4.4. Self-efficacy and convenience technologies have positive and significant effects on perceived behavioral control.**

This study found that self-efficacy and convenience technologies had positive and significant effects on perceived behavioral control (Shih and Fang, 2004; Zaman et al., 2021). Participants could successfully operate and use the Active Arcade App by themselves even without teaching, demonstrating their belief that using the app was within their own ability. Notably, convenience technologies exerted the greatest impact factor on perceived behavior control. This suggests that users perceived the technological equipment used to access the Active Arcade App as sufficient for smooth gameplay and a satisfactory experience. It indicates that users believed they possessed the ability to use the Active Arcade App at any time due to their perceived access to adequate resources and the necessary hardware (mobile phones) for normal software operation. Therefore, convenience technologies had a significant positive impact on perceived behavior control, establishing them as the key factor influencing perceived behavioral control. This result is consistent with previous research on organic food consumption behavior (Tsai et al., 2015), as well as the findings of Choi

and Park (2020), Gangwal and Bansal (2016), Lin et al. (2019) and Sadaf and Gezer (2020).

#### **4.5. Attitude, subjective norm, and perceived behavioral control have positive and significant effects on behavioral intention.**

In this study, attitudes, subjective norms, and perceived behavioral control had positive and significant effects on behavioral intentions. These findings are consistent with the results of Chang et al. (2020), Lin et al. (2019), Munoz et al. (2017) on Exercise Behavior, Xia et al. (2021) on the use of traditional Chinese medicine, Yu et al. (2021) and Zaman et al. (2021) on the adoption of big data analytics technologies in disaster management. Among them, subjective norm had the greatest impact factor on behavioral intention, indicating that for users, perhaps the threat of the epidemic may have caused people to regulate their own health, be aware of the threat of the epidemic and how it affected their lives, and know the importance of health and start to exercise independently.

### **5. Conclusions**

In the post-pandemic era, home fitness mobile apps have led to a new training trend. This study found that the decomposed theory of planned behavior can explain people's usage behavior of AR sports games. The factors influencing users depend on the enjoyment derived from the app, and perceived playfulness is a crucial factor in enhancing user attitudes. Additionally, under the influence of the epidemic, people were regulated by their own physical health, perceiving the threat of the epidemic which was sufficient to impact their lives and recognizing the importance of health, thus initiating independent exercise.

#### **5.1. Managerial and practical implications**

According to the analysis of the current situation, "I think I've had a lot of fun with Active Arcade" was the highest impact factor in the perceptual playfulness dimension. It is suggested that the App development teams should design and develop more diverse and interesting games according to the current App game rankings in order to prevent existing App users from discontinuing to use the App due to the feeling of boredom caused by playing too many times.

According to the analysis of the current situation, "I think exercising with Active Arcade can boost my body immunity" was the highest impact factor in perceived exercise benefits. Living under the threat of the epidemic and avoiding crowds, using apps to exercise at home was bound to become a popular trend, and Active Arcade App can also be one of the choices for people. Therefore, it is suggested that the App development teams can develop sports games, sports training, or increase the difficulty of the games to suit the exercise intensity of many users to achieve the purpose of exercise and make Active Arcade App a more comprehensive application.

From the dimension of theory of planned behavior, attitude, subjective norm, and perceived behavioral control, subjective norm has the greatest influence on the coefficient of behavioral intention. It is conceivable that during the epidemic, everyone received external information and was greatly influenced by relatives and friends, and

then recognized their own physical conditions and changed their behavioral intentions. Therefore, it is recommended that the App teams promote advertisements so that more people or news media can influence people around them and then start doing exercises.

## **5.2. Research limitations and future research suggestions**

### **5.2.1. Research limitations**

First of all, this study was conducted during the post-pandemic era; it cannot represent future usage of the software. Secondly, due to the rapid development of AI and AR, if these results are used to compare with future similar sports and fitness software, attention should be paid to the differences in software characteristics. Thirdly, due to the unrestricted usage of Active Arcade App by one or multiple users simultaneously in this study, the results may differ from studies of other software with user limitations.

### **5.2.2. Future research suggestions**

First of all, the scale of perceived exercise benefits was designed during a period of reduced COVID-19 prevalence in Taiwan, and the questionnaires were issued in the post-pandemic era in Taiwan; therefore, the questionnaire items may not be suitable which caused the goodness of fit test to fail and the deletion of questions. It is suggested that scholars need to pay more attention to the regulations of the government's epidemic prevention policies if they consider the epidemic as a research variable in the future. Besides understanding the factors that affect the use of apps by different age groups, it is also possible to further develop suitable games to meet the needs of each ethnic group. Finally, this study aims to understand the behavioral intentions of the public in using the Active Arcade application for fitness training. However, the individual fitness effects achieved cannot be measured, which may also affect their usage behavior. It is suggested that future analyses incorporate factors such as software usage frequency and exercise effectiveness.

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