

AR Mobile Games Adoption: A Study among University Students in Malaysia

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Abstract: *In the era of mobility, augmented reality (AR) is a familiar name in the gaming industry. The rise of AR mobile games were not without consequences. Accidents were often heard as a result of AR mobile game addictions. These happened on the roads, playing the games while walking and driving. This research is aimed at determining the factors influencing the behavioural intention to adopt AR mobile games among university students in Malaysia. Two models – Theory of Planned Behaviour and Information System Success – were adopted, combining four independent variables such as attitude, subjective norms, perceived behavioural control and system quality while adding immersion as a new element. Primary data in terms of self-administered and online questionnaires were distributed to six universities. The collected data were then analysed quantitatively using SPSS 20.0 and the outcomes supported all hypotheses. Attitude was the strongest factor to influence the behavioural intention to adopt AR mobile games among university students. This research is a contribution to empirical knowledge. It can also be a guide to game developers in designing a safer game environment while enhancing technology.*

Keywords: augmented reality, mobile games, Pokemon Go, Malaysia

1. Introduction

Mobile technologies have swept into the consumer segments making heavy impacts in the last few years. Major improvements in mobile broadband networks and the existence of many mobile gaming technologies have opened up new opportunities and possibilities for the development of mobile games industry [1]. The most current development has been the growing popularity of augmented reality (AR) mobile games.

AR was a new trend of digital world, which enhanced the real world with virtual information [2]. AR is defined as “a real-time direct or indirect view of a physical real-world environment that has been enhanced or augmented by adding virtual computer-generated information to it” [3]. AR has the potential for people to see beyond of what they see, hear beyond of what they hear and perceive beyond of what they perceive [4]. AR delivered real objects associated with digital information simultaneously to the user by enriching the sense of the user’s imagination by reforming the real world [4]. Thus, a close real time interaction between virtual and real objects enabled users to judge several constraints simultaneously and analyse problems efficiently [5].

AR provides opportunities in various industries including education, medical procedures, manufacturing, marketing, entertainment and tourism [6,7] and games [8]. As gaming applications are the best tools to recognise AR technology [9], AR research worked closely with game industries to develop extensive new game applications. One of the results of a successful AR mobile application was launched in 2016 – the Pokémon Go [10]. Briefly, players of Pokémon Go are required to search and detect the location for new hidden virtual creatures, hence, the players are able to catch new creatures from the real world [11]. As a consequence, findings have shown that AR mobile games like Pokémon Go may lead to increased risk of physical accident and

mental harm when playing the game while driving and walking [12,13]. This is mainly due to players of AR mobile games tend to get distracted and neglect the safety issue in their surroundings [14].

In the following sections, the problem statement, research objectives, literature review, proposed conceptual framework, research methodology, research results, discussion and conclusion will be presented.

2. Problem Statement

While research interest in AR games have emerged in the past five years, scholars mostly are focusing more on user adoption behaviour [15,11], marketing potentials [16], and user requirements [17]. However, there are still lacking of frameworks in prior researches that investigated why and how consumers play AR games [11]. In other words, limited researches have been conducted on mobile AR gaming in the consumer behaviour context. In addition, there are limited theories applicable to AR technologies. Previously, common models for adopting AR technology used are Uses & Gratification Theory [11], Technology Acceptance Model (TAM) [18,19] and Unified Theory of Acceptance and Use of Technology (UTAUT) [20]. Very limited studies have applied Theory of Planned Behavior (TPB) and DeLone and McLean’s Information System Success model in AR and mobile game applications. Therefore, this research addresses the gap by focusing on the factors that influenced the player’s behavioural intention (BI) to adopt AR mobile games by adopting the two theories.

3. Research Objectives

To be specific, this research aims to investigate the relationship between Attitude, Subjective Norms, Perceived Behavioural Control, Immersion and System Quality and the

behavioural intention to adopt AR mobile games among university students in Malaysia.

4. Literature Review

This study examines factors influencing behavioural intention through the lenses of two adopted theories: Theory of Planned Behaviour and DeLone and McLean's Information System Success Model. Immersion was added as a new element into this study together with the other independent variables (IVs): Attitude, Subjective Norm, Perceived Behavioural Control and System Quality. An overview of these theories and model is provided in the next section.

4.1 Theory of Planned Behaviour (TPB)

Theory of Planned Behaviour (TPB) is one of the most influential models for the prediction of human behaviors [21]. This theory has been applied in many research areas. For example, Tagoe and Abakah[22] have used TPB to explain the factors influencing the behavioural intention of students at University of Ghana Distance Education to adopt mobile learning. In Malaysia as well, TPB model was used to investigate the factors influencing the adoption of e-filing. In this study, subjective norm is positively associated with intention of taxpayer to use e-filing [23]. Besides, in a study by Danila and Akilah[24], TPB was used to investigate user's intention and usage of e-government services.

Developed from the Theory of Reasoned Action (TRA), TPB preserves what TRA hypothesized about human behaviour but it incorporates some modifications to allow for more accuracy and reliability in understanding human behaviour. All three variables: Attitude (AT), Subjective Norm (SN) and Perceived Behavioural Control (PBC), from this theory were adopted for this study.

Attitude is an individual's positive or negative judgment about behaviour and formed through behavioural belief [25]. Several studies have shown a significant and positive outcome concerning attitude towards the intention to use technology. A research on the acceptance of cloud-based m-retail application among 384 Malaysian textile cyberpreneurs shows a positive relationship between the attitude and behavioural intention to adopt the application [26]. Another study conducted by Alzahrani *et al.* [21] to examine the factors of actual practice in playing online games also indicates a positive relationship between attitude and actual practice in playing online games among 1584 students in Universiti Sains Malaysia.

Subjective norm (SN) is defined as an individual's perception of the social pressure to perform or not to perform the target behaviour[25]. It can also be explained as the individual's perception of other people's views and beliefs on the suggested behaviour. Many studies have shown that the significant and positive effect of SN towards intention to use technology. According to Ting, Yacob, Liew and Lau [27], SN would positively influence the intention to adopt m-payment systems among 311 Malays and Chinese mobile users in Malaysia. Another study conducted by Cheung and To[28] has proved that SN has positive impact on young

Chinese mobile users in Hong Kong regarding their behavioural intention to watch in-app advertisements.

Perceived behavioural control (PBC) according to Ajzen[25], refers to people's perception on the ease or difficulty in performing the behavior of interest. It is correlated to the individual's confidence and presence of control that may facilitate or impede the behaviour[29]. Several studies have shown that PBC has a significant and positive impact on the intention to use technology. In a past study conducted by Teo, Zhou and Noyes [30], regarding the use of technology for teaching and learning, has found that the teachers' PBC has a positive influence. Yakasai and Jusoh[31] in their study as well has found that PBC has a positive relationship with behavioural intention to use digital coupon among 392 IUKL students in Malaysia.

4.2 DeLone and McLean's Information System Success Model (DMIS)

DeLone and McLean's Information Systems Success model (DMIS) was also used in this study. DMIS is an Information System (IS) Theory, which was published by DeLone and McLean in 1992 for the purpose to merge past IS studies carried out by researchers in 1970s-1980s into a more consistent body of knowledge and thus provides guidance for future research [32]. The original model developed in 1992 explains the interrelated relationship of the six dimensions which include System Quality (SQ), Information Quality (IQ), Use, User Satisfaction, Individual Impact, and Organizational Impact. The model was updated in year 2003 and Service Quality (SVQ) was added as a new measurement together with the intention to use. It also combined the impact of individual and organizational into net benefits [32]. DMIS has been used in many research areas for example in mobile banking [33] and also e-learning [34]. From this model, System Quality (SQ) was chosen as one of the IVs in order to see the impact of this variable towards the behavioral intention to adopt AR in mobile games.

System quality (SQ) is usually measured under the dimensions of flexibility, reliability, functionality, ease of use, data importance, integration, and quality [32]. DeLone and McLean [35] illustrated that an individual's behavioural intention to use a particular system is commonly influenced by the application's system quality. Several researches have shown significant and positive effects of SQ towards intention to use technology. A research by Park and Kim [36] on the use of mobile cloud services among 1099 undergraduate students in South Korea has shown SQ and behavioural intention had a positive and significant relationship. In another study, Mohammadi[34] has identified that SQ is a significant influence on user's intention to use e-learning. The study was conducted at four public universities in Iran.

4.3 Immersion

As stated earlier, immersion was added as a new variable in this study in order to have a better insight on the subject as Young [37] has highlighted that some activities involving chess, book, conversation and videogames are immersive. Witmer & Singer define immersion as the degree to which an

individual are attracted by or engaged in an experience (as cited in Alexander, Brunyé, Sidman, & Weil [38]. Immersion has been used in various research areas for example in a research by Disztinger, Schlögl, and Groth [39], immersion is used to estimate the intention to apply VR technology in tourism. Moreover, immersion is assessed as one of the characteristics of technology in Virtual Environment [40].

4.4 Proposed Conceptual Framework

Based on Theory of Planned Behaviour (TPB), DeLone and McLean’s Information System Success Model (DMIS) and Immersion construct, the proposed conceptual framework is presented in Figure 1 below.

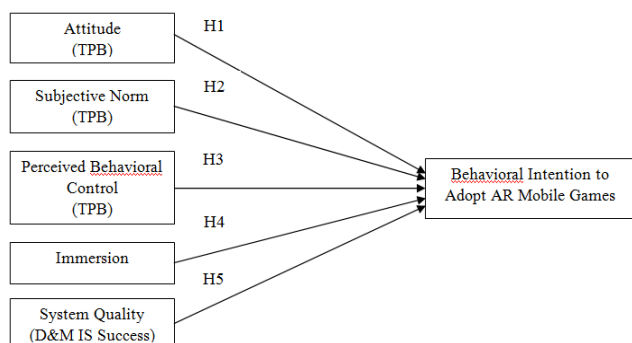


Figure 1: Proposed Conceptual Framework

4.5 Hypotheses Development

Next, five hypotheses have been developed and tested. They are as the following:

- H1 There is a positive relationship between Attitude and behavioural intention to adopt AR in mobile games among university students.
- H2 There is a positive relationship between Subjective Norm and behavioural intention to adopt AR in mobile games among university students.
- H3 There is a positive relationship between Perceived Behavioural Control and behavioural intention to adopt AR in mobile games among university students.
- H4 There is a positive relationship between Immersion and behavioural intention to adopt AR in mobile games among university students.
- H5 There is a positive relationship between System Quality and behavioural intention to adopt AR in mobile games among university students.

5. Research Methodology

This research involved a cross-sectional study and the unit of analysis is the university students. Self-administered as well as online questionnaires are the medium used for data collection. There are about 20 public (estimated 538 555 students) and 47 private (estimated 666 617 students) institutions of higher learning in Malaysia [41]. The sampling locations involved four public and two private universities. They are Universiti Malaya (UM), Universiti Putra Malaysia (UPM), UniversitiKebangsaan Malaysia (UKM), UniversitiSains Malaysia (USM), UniversitiTunku Abdul Rahman (UTAR) and UniversitiTeknologiPetronas

(UTP). These universities are chosen as they are among the top ranks in Asia with high number of full-time equivalent student enrolments. Since the questionnaire consisted of 30 items, the desirable sample size is between 120-300 respondents. By adopting convenience sampling method, 258 responses have been collected.

6. Results of Research

6.1 Demographic Profile of the Respondents

In this section, the results of the research will be discussed. In total, 258 university students took part in this research (Table 1). Out of the 258 respondents, 51.94% (134) were male students while the other 48.06% (124) were female students. A majority of the students were between 20-25 years of age (89.92%, 232 students). The questionnaires were distributed equally between six universities (16.67%, 43 sets each). The selected universities were Universiti Malaya (UM), Universiti Putra Malaysia (UPM), UniversitiKebangsaan Malaysia (UKM), UniversitiSains Malaysia (USM), UniversitiTunku Abdul Rahman (UTAR) and UniversitiTeknologiPetronas (UTP). Next, most of the respondents were pursuing their undergraduate programmes (90.70%, 234 students). When asked about playing mobile games, more than half reported that they have experienced playing mobile games (77.13%, 199 respondents) while 147 respondents (56.98%) admitted that they have played AR mobile games before.

Table 1: Demographic Profile of the Respondents

Gender	Frequency	Percentage (%)
Male	134	51.94
Female	124	48.06
Age	Frequency	Percentage (%)
Below 20 years old	22	8.53
20-25 years	232	89.92
26-30 years	3	1.16
Above 30 years	1	0.39
Name of University	Frequency	Percentage (%)
Universiti Malaya	43	16.67
Universiti Putra Malaysia	43	16.67
UniversitiKebangsaan Malaysia	43	16.67
UniversitiSains Malaysia	43	16.67
UniversitiTunku Abdul Rahman	43	16.67
UniversitiTeknologiPetronas	43	16.67
Current Education Level	Frequency	Percentage (%)
Foundation	19	7.36
Diploma	1	0.39
Degree	234	90.70
Master	4	1.55
Have you played mobile games?	Frequency	Percentage (%)
Yes	199	77.13
No	59	22.87
Any experience playing AR mobile games?	Frequency	Percentage (%)
Yes	147	56.98
No	111	43.02
Total	258	100.00

6.2 Reliability Analysis

Based on Table 2, the Cronbach Alpha for each variable ranged from 0.7158 to 0.9304. All survey items are thus,

considered reliable and consistent as their Cronbach Alpha is more than 0.7 [42].

Table 2: Reliability Test

Independent Variable	Cronbach Alpha	Dependent Variable	Cronbach Alpha
Attitude	0.9168	Behavioural Intention to Adopt AR Mobile Games	0.9304
Subjective Norms	0.7158		
Perceived Behavioural Control	0.7924		
Immersion	0.8677		
System Quality	0.8055		

6.3 Pearson Correlation Analysis

Table 3 illustrated the results of the Pearson Correlation Analysis. All variables have a positive correlation with behavioural intention to adopt AR mobile games. Attitude had the strongest relationship (0.62459), followed by Perceived Behavioural Control (0.58945) and System Quality (0.53752). On the other hand, Immersion (0.49157) and Subjective Norms (0.49739) both had the weakest relationship with behavioural intention to adopt AR mobile games.

Table 3: Pearson Correlation Analysis

Variables	Behavioral Intention (BI)
Attitude	0.62459 <.0001
Subjective Norms	0.49739 <.0001
Perceived Behavioural Control	0.58945 <.0001
Immersion	0.49157 <.0001
System Quality (SQ)	0.53752 <.0001

6.4 Multicollinearity Test

Multicollinearity test is performed to examine the correlations and ensure that the variables are not highly correlated with one another (>0.90). Based on Table 4, all the variables were not highly correlated as all the correlations were below 0.90. Hence, multicollinearity problem did not exist in this research.

Table 4: Multicollinearity Test

Variables	AT	SN	PBC	IM	SQ
Attitude	1.00000				
Subjective Norms	0.44373 <.0001	1.00000			
Perceived Behavioural Control	0.63787 <.0001	0.44925 <.0001	1.00000		
Immersion	0.39155 <.0001	0.38275 <.0001	0.39253 <.0001	1.00000	
System Quality	0.53395 <.0001	0.42905 <.0001	0.50501 <.0001	0.31545 <.0001	1.00000

6.5 Multiple Linear Regression- Model Summary

The R-square value of 0.5425 as shown in Table 5 indicated that 54.25% of the behavioural intention to adopt AR mobile games in this research can be explained by all the five independent variables chosen.

Table 5: Multiple Linear Regression - Model Summary

Root MSE	0.68020	R-Square	0.5425
Dependent Mean	3.43895	Adjusted R-Square	0.5334
Coefficient Variation	19.77925		

In addition, since the p-value for all independent variables were smaller than 0.05, thus, all hypotheses were supported. All independent variables – Attitude, Subjective Norms, Perceived Behavioural Control, Immersion and System Quality were positively related to behavioural intention to adopt AR mobile games among university students in Malaysia (Table 6).

Table 6: Summary of Multiple Linear Regression Analysis

Variable	Parameter Estimate	Pr > t	Hypothesis Testing	Standardized Estimate	Tolerance	Variance Inflation
Intercept	-1.23220	<.0001	Supported	0	.	0
Attitude	0.36034	<.0001	Supported	0.27089	0.51047	1.95898
Subjective Norms	0.19238	0.0062	Supported	0.14115	0.69506	1.43872
Perceived Behavioural Control	0.25992	0.0018	Supported	0.18511	0.52544	1.90318
Immersion	0.22001	<.0001	Supported	0.20375	0.77275	1.29409
System Quality	0.27125	0.0012	Supported	0.17456	0.63962	1.56344

7. Discussion and Conclusion

In summary, attitude has a positive relationship with the behavioural intention to adopt AR mobile games among university students in Malaysia. This finding is consistent with past studies conducted by Ghani *et al.* [26] and Alzahraniet *et al.* [21]. In addition, students also played AR mobile games when they are influenced by the significant others. This result is similar to Ting *et al.*[27] and Cheung and To[28].

Perceived behavioural control is found to have a significant impact on the behavioural intention to adopt AR mobile games among the university students. The same outcome can be found in Teo *et al.* [30] and Yakasai and Jusoh[31]. Generally, the students were at ease in playing the AR mobile games. Moreover, system quality is positively related with the behavioural intention to adopt AR mobile games. This is consistent with the studies of Park and Kim [36] and Mohammadi[34]. It is important for game developers to pay attention into system quality aspect of the mobile game development as features like functionality, ease of use, data importance, integration, and device quality are a close influence to behavioural intention of adoption.

Immersion is found to have a positive correlation with behavioural intention to adopt AR mobile games. This finding is in agreement with Distingeret *al.* [39]. However, players are at risk of losing their concentration on the road or while walking because they are too absorbed in the games. Thus, this poses a challenge to game developers and the authority to ensure that the safety aspect of the games is not neglected as it involved human lives and the environment. Public awareness and education programmes to the tech savvy groups are very important, as this is the reason of conducting this research. These issues opened up avenues for more research and experiment opportunities for future research.

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