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Investigating the Demographic Characteristics of University Students' Perceptions towards Their Intention to Adopt a Mobile Augment Reality App for Entertainment and Shopping Purposes: A UTAUT Model Perspective

Vaggelis Saprikis[1], Giorgos Avlogiaris[2] and Androniki Katarachia[3]

[1,2,3] University of Western Macedonia, Greece

Abstract.

Nowadays Augmented Reality (AR) is gradually adopted by even more individuals. Its ability to project various forms of digital information on the real world has created great prospects to stakeholders, especially to the mobile industry, and numerous smartphone users take advantage of AR features provided on mobile applications. Thus, academic community and the industry have eagerly tried to understand and anticipate how this quite new to the mass audience technology affects individuals' perceptions, adoption intention and level of use. Thus, the scope of this empirical paper is to investigate user's perceptions towards their behavioral intention to adopt a mobile AR app in shopping malls by analyzing their demographic characteristics. For this reason, the study utilizes the Unified Theory on Acceptance and Use of Technology (UTAUT) established by Venkatesh et al. in 2003 and focuses on university students. The results provide tangible insights to both academia and practitioners as the analysis of demographics reveal not only similarities, but also differences between examined features.

Keywords: augmented reality, UTAUT, students' perceptions, demographics, shopping mall, mobile services

1. Introduction

The progress of mobile technology industry, mainly in mobile networking and smartphones, has significantly altered our everyday life. One of the technological solutions which is greatly related to the mobile industry and is applied more and more nowadays in various forms is Augmented Reality (AR). AR is defined as a technology that merges real and computer-generated digital information into the user's view of the physical and interactive real world in such a way that they appear as one

environment (Höllerer & Feiner, 2004; Klopfer & Squire, 2007; Vallino, 1998; Wellner & MacKay, 1993). To be more specific, AR permits users to see dimensional virtual objects upon the real world (Haller et al., 2007) by bridging the gap between the real and the virtual in a seamless way (Chang et al., 2010).

However, despite the fact that AR has already been investigated for more than 35 years, quite recently, AR has been transformed to a popular and somehow inexpensive technology to use. This is greatly based on current smartphones' features required for mobile AR applications; which are a good quality camera, a relatively fast internet connection, a GPS and a digital compass (Olsson & Salo, 2011); along with AR development kits which have been provided to developers from technology giants, such as Google's ARCore and Apple's ARKit. According to Azuma et al. (2011), mobile AR is considered as one of the fastest growing research areas in the AR field, due to the rise and widespread acceptance of smartphones that provide powerful platforms for supporting AR on a mobile environment. Up to now, mobile AR applications have been developed in several industries, mainly in gaming industry, retail, marketing, tourism, education, construction and culture (e.g., Chung et al., 2015; He et al., 2018; Jung et al., 2015; Kang, 2014; Kourouthanassis et al., 2015; Lee, 2012; Lum, 2013; Olsson et al., 2013). Nevertheless, the AR app which successfully introduced AR to a mass audience has been the 'Pokemon Go' (Wingfield & Isaac, 2016); a mobile app with over one billion downloads in less than 3 years (Van Boom, 2019) providing AR's capabilities through gaming industry. According to Forbes Agency Council (2017), AR is expected to be enhanced in the market and is estimated to reach $117.4 billion by 2022 at a compound annual growth rate of 75.72%.

Concerning its business-oriented approach, AR technology has already been investigated in various forms from the academic community. For example, Olsson & Salo (2011) have focused on its utilization, Lee (2012) and Martínez et al. (2014) on its applications and limitations, Chung et al. (2015) and Kang (2014) on its usage intention, and Bojórquez et al. (2016) and Javornik et al. (2016) on its adoption intention. In this standpoint, this empirical paper examines smartphone users' behavioral intention to adopt mobile AR apps in shopping malls in Greece. Specifically, it aims to reveal if there are differences on their perceptions towards such apps based on their demographic characteristics by applying Venkatesh's et al. (2003) Unified Theory on Acceptance and Use of Technology (UTAUT) model. The results are expected to offer tangible insights to both academia and the industry.

The paper is organized as follows. In Session 2 literature review is provided, followed by the applied research methodology and the results of the empirical study in sections 3 and 4 respectively. The last section includes a discussion of the results, its limitations and future research perspectives.

2. Literature Review

A literature review on innovative technology highlights a number of theories normally used or enhanced with other variables for investigating several contexts of technology adoption. Hence, there are quite a few behavioral intention schemes, such as the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), the Theory of Planned Behavior (TPB) (Ajzen, 1991), the Diffusion of Innovations (DOI) theory (Rogers, 2003), etc. Regarding AR behavioral intention, however, the research community has broadly applied the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT).

In specific, the Technology Acceptance Model (TAM) highlights that perceived usefulness and perceived ease of use are the two main beliefs that determine one's intention to use technology (Davis, 1989). When deeper justification of user adoption intention is anticipated, it allows other factors to be combined easily into its basic model (Hong et al., 2006). TAM has been the most popular applied model in AR adoption. For example, rese et al. (2014) proved the positive effect of perceived ease of use, perceived usefulness and enjoyment on behavioral intention to adopt the IKEA's AR mobile catalogue app and Rauschnabel & Ro (2016) approved the significance of functional benefits, ease of use, individual difference variables, brand attitudes, and social norms in AR smart glass behavioral adoption. Furthermore, Haugstvedt & Krogstie (2012) confirmed the impact of perceived usefulness and enjoyment on mobile AR adoption for cultural heritage and Balog & Pribeanu (2010) emphasized that perceived usefulness and enjoyment have a significant impact on the behavioral intention to utilize an AR teaching platform.

As regards the Unified Theory of Acceptance and Use of Technology (UTAUT), it incorporates numerous models based on the theories mentioned above plus a few of their extensions, in a unified technology acceptance perception. The UTAUT comprises five factors; performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioral intention (Venkatesh et al., 2003). About a decade later Venkatesh et al. (2012) also settled UTAUT 2, which enhanced the earlier theory by including three additional variables; hedonic motivation, price value and habit. Regarding its application to AR adoption context, a number of empirical examinations have been taken place. For instance, Shang et al. (2017) confirmed the impact of performance expectancy and facilitating conditions to the adoption of a mobile AR app for historical monuments and Paulo et al. (2018) used the UTAUT 2 in order to investigate the behavioral intention to adoption AR in tourism.

Based on UTAUT, the present paper aims to investigate university students' perceptions towards mobile AR apps in shopping malls. In specific, it examines if there are differences on their insights based on their demographic characteristics; that are the gender, their university rank and the place of their residence. Shopping malls have been the current basic trend worldwide for shopping, entertainment, meeting with friends and relatives, as well as eating out. From this perspective, the results

deriving from the examination of users' perceptions towards mobile AR apps in shopping malls are considered particularly valuable.

3. Methodology

To investigate the aforementioned research scope, an anonymous e-questionnaire was developed and administered to Greek university students the first three months of 2019. Sampling included university students has frequently applied in empirical research in various studies (e.g., Saprikis, 2018; Saprikis & Antoniadis, 2019; Shead et al., 2012). As regards its measurement items, it is worth noting that are based on previous surveys approved for their validity and reliability but were modified to fit the study context (Table 1). Furthermore, a sample of thirty responses along with e-questionnaire's revision by two academics enable recognizing any possible problem constraints in terms of clarity and accuracy.

The measurement instrument was uploaded on a website and an e-mail was sent to members of various student lists and closed university student groups in Facebook asking them to answer the questions. The e-questionnaire was introduced by a detailed text along with a video that explained in detail AR technology and the purpose of the research. 381 students completely responded to it and comprised the sample of the study (Table 2).

To test if there are differences on students' perceptions based on their gender and place of residence, a two-stage data analysis was conducted. The first stage employed factor analysis using Principal Component Analysis (PCA) and orthogonal rotation (VARIMAX) to test the data validity and reliability, followed by stepwise regression analyses. Except for the demographic characteristics (Table 2), for all questions a 5-point Likert scale was applied. Details of the measurement item scales are demonstrated in Table 1.

Table 1: The operational definition of research variables

Research variables	Operational definition	Sources
Performance Expectancy	**PE1**: I think that using an AR app in a shopping mall would help me accomplish things more quickly	Adapted from Kang (2014); Venkatesh et al. (2012)
	PE2: I think that using an AR app in a shopping mall would increase my chances of achieving things that are important to me	
	PE3: I would find an AR app in a shopping mall to be useful	
Effort Expectancy	**EE1**: I think that learning how to use an AR app in a shopping mall would be easy for me	Adapted from Kourouthanassis et al. (2015); Venkatesh et al. (2012)
	EE2: I think that it would be easy for me to become skillful at using an AR app in a shopping mall	

	EE3: I think that my interaction with an AR app in a shopping mall would be clear and understandable	
	EE4: I think that I would find an AR app in a shopping mall easy to use	
Social Influence	**SI1**: People who are important to me think that I should use an AR app in a shopping mall	Adapted from Giovanis et al. (2019); Venkatesh et al. (2012)
	SI2: People who influence my behavior think that I should use an AR app in a shopping mall	
	SI3: People whose opinions I value prefer that I should use an AR app in a shopping mall	
Facilitating Conditions	**FC1**: I think that I have the smartphone necessary to use an AR app in a shopping mall	Adapted from Chung et al. (2015); Venkatesh et al. (2012)
	FC2: I think that I have the knowledge necessary to use an AR app in a shopping mall	
	FC3: I think that I can use an AR app in a shopping mall with my current smartphone	
Behavioral Adoption	**BA1**: Given the chance, I intend to use an AR app in a shopping mall	Adapted from Chung et al. (2015); Giovanis et al. (2019); Kang (2014); Venkatesh et al. (2012)
	BA2: I intend to use an AP app in a shopping mall	
	BA3: I predict I will use an AR app in a shopping mall in the future	
	BA4: I will use an AR app if is provided in a shopping mall	
	ENJ2: I think using an AR app in a shopping mall would be a pleasure process	
	ENJ3: I think using an AR app in a shopping mall would be enjoyable	

Table 2: Demographics of the sample

Demographic Characteristics	**Respondents**
Sex:	
Male	229
Female	152
University rank:	
Freshmen	190
Sophomores	124
Juniors	29
Seniors	17
Graduate student	21
Place of residence:	
City	29
Town	207
Small town	78
Village/ Countryside	67

4. Results

First, factor analysis was applied to test the validity of the variables, classify and reduce questions into sub-variables when possible, and calculate factor loadings. In specific, the Principal Component Analysis (PCA) using orthogonal rotation (VARIMAX) was performed to estimate the underlying structure of the data. The PCA method is mostly appropriate to summarize the most of the original information (variance) in a minimum number of factors for prediction purposes (Hair et al., 2006). Orthogonal extraction, using VARIMAX rotation, suited for research goals and the necessity to reduce a large number of variables to a smaller set of uncorrelated variables. Furthermore, VARIMAX rotation attempts to minimize the number of variables that have high loadings on a factor; thus, enhancing the interpretability of the factors (Hair et al., 2006). To test the appropriateness of the data for factor analysis, however, several measures were applied to the entire population matrix. To be more specific, Bartlett's test of sphericity ($p = .0$) approved the statistical probability that the correlation matrix has significant correlations among the variables, whereas the result of Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .902, which is meritorious. Moreover, the Measure of Sampling Adequacy (MSA) values all exceed .50 for both the overall test and each individual variable (Hair et al., 2006). As a consequence, all the aforementioned measures showed the suitability of factor analysis.

By applying the Kaiser Eigenvalues criterion, five factors were extracted which jointly explained 76.601% of the variance in all items, whereas all the communalities were greater than .50, ranging from .560 to .868, providing adequate interpretation (Hair et al., 2006). Concerning construct validity, which testifies how well the results obtained from the use of the measure fit the theories around which the test is designed (Crabbe et al., 2009), it was tested by the utilization of two broadly applied tests, convergent and discriminant validity. In detail, "convergent validity is demonstrated if the items load strongly (> .50) on their associated factors, whereas discriminant validity is achieved if each item loads stronger on its associated factor than on any other factor" (Hair et al. 2006). Table 3 shows that all items have loading greater than .50 and load stronger on their associated factors than on other factors. Therefore, convergent and discriminant validity are demonstrated. The five factors - Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions and Behavioral Intention - proved to be comparatively easy to interpret, owing to the strong variable loadings. Finally, construct reliability (or internal consistency) was assessed using Cronbach's alpha. Table 3 also shows that values ranged from .804 to .916. According to Hair et al. (2006), scores greater than .70 are considered acceptable for field research.

Table 3: Rotated component matrix

Items	Behavioral Intention	Effort Expectancy	Social Influence	Performance Expectancy	Facilitating Conditions
EE1	.142	**.681**	.208	.352	.144
EE2	.203	**.761**	.173	.265	.104
EE3	.114	**.728**	.171	.049	.140
EE4	.203	**.790**	.201	.092	.160
FC1	.069	.134	.082	.060	**.910**
FC2	.171	.407	.318	.023	**.513**
FC3	.146	.162	.192	.104	**.879**
SI1	.127	.204	**.843**	.082	.112
SI2	.194	.180	**.831**	.093	.149
SI3	.170	.263	**.824**	.103	.167
BI1	**.760**	.203	.171	.255	.154
BI2	**.847**	.130	.182	.277	.071
BI3	**.853**	.163	.173	.193	.059
BI4	**.801**	.199	.102	.297	.155
PE1	.363	.164	.076	**.792**	.083
PE2	.298	.157	.123	**.828**	.078
PE3	.438	.335	.091	**.676**	.045
Cronbach's Alpha	**.885**	**.870**	**.804**	**.916**	**.836**

Six, separate, stepwise regression analyses were applied to assess the best predictors among UTAUT's independent variables believed to impact on mobile AR app behavioral intention. According to Hair et al. (2006), stepwise regression is considered as the most popular sequential approach to variable selection. In specific, these six analyses were applied to examine each of the three demographic characteristics of the sample. Therefore, two regression analyses investigated the gender of the respondents – a. male and b. female -, two regression analyses investigated their place of residence - a. city/ town and b. small town/ village-countryside -, and two regression analyses examined their university rank – a. freshmen and b. sophomores/ juniors/ seniors/ graduate students. We decided to group together city and town responses; and small town and village-countryside responses with the aim to reveal possible differences based on the number of inhabitants. Following the same procedure, we analyzed separately freshmen from the rest of the

sample because we believe that they might reveal differences as this is their first year in a new and completely different educational environment. The results of the six regression analyses are as follows (Table 4).

Table 4: Results of the stepwise regression analyses

Model	R	R Square	Adjusted R Square		Change Statistics				
				Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1: Male	.731	.535	.531	.63785	.044	21.393	1	226	.000
2: Female	.715	.511	.504	.68501	.046	14.129	1	149	.000
3: City/ Town	.744	.554	.548	.65522	.009	4.836	1	232	.029
4: Small town/ Village-countryside	.693	.480	.473	.65113	.063	17.209	1	142	.000
5: Freshmen	.700	.490	.484	.70540	.034	12.407	1	187	.001
6: Sophomores/ Juniors/ Seniors/ Graduates	.749	.562	.555	.59848	.009	3.969	1	187	.048

[1] Predictors: (constant), Performance Expectancy, Social Influence

[2] Predictors: (constant), Performance Expectancy, Social Influence

[3] Predictors: (constant), Performance Expectancy, Social Influence, Facilitating Conditions

[4] Predictors: (constant), Performance Expectancy, Social Influence

[5] Predictors: (constant), Performance Expectancy, Social Influence

[6] Predictors: (constant), Performance Expectancy, Social Influence, Facilitating Conditions

Regarding the gender, the results indicate that males and females are both influenced by Performance Expectancy and Social Influence, whereas Effort Expectancy and Facilitating Conditions were not supported. In specific, males' results indicate that 73.1% of the variance in AR behavioral intention is explained by the Performance Expectancy and the Social Influence. Performance Expectancy has the highest explanatory value of 70.1% (b = .638, t = 13.496, p = .0) and Social Influence has 3% (b = .219, t = 4.625, p = .0). Regarding females, the 71.5% of the variance is explained by the Performance Expectancy (68.1%, b = .588, t = 9.428, p = .0) and Social Influence (3.4%, b = .235, t = 3.759, p = .0) as well.

Concerning the place of residence, a significant difference was revealed between the two examined groups. In particular, students who stay in towns and cities seem to be influenced by the Performance Expectancy, Social Influence and Facilitating Conditions, whereas students who live in small towns and village-countryside got impacted only by Performance Expectance and Social Influence. Regarding the former, the results indicate that 74.4% of the variance in AR behavioral intention is explained by Performance Expectancy (71.7%, b = .612, t = 12.346, p = .0), Social Influence (2.1%, b = .151, t = 2.947, p = .004) and Facilitating Conditions (1.4%, b = .112, t = 2.199, p = .029). Regarding the latter, the 69.3% of the variance is explained by the Performance Expectancy (64.6%, b = .593, t = 9.582, p = .0) and Social Influence (4.7%, b = .257, t = 4.148, p = .0).

As regards to the university rank, a significant difference was revealed between the two examined groups as well. In particular, freshmen got influenced by the Performance Expectancy and Social Influence, whereas students from the rest of the university ranks got influenced by the same factors and Facilitation Conditions as well. Regarding the former, the results indicate that 70% of the variance in AR behavioral intention is explained by Performance Expectancy (67.5%, b = .624, t = 11.507, p = .0) and Social Influence (2.5%, b = .191, t = 3.522, p = .001). Concerning the latter, the 74.9% of the variance is explained by the Performance Expectancy (70.4%, b = .565, t = 10.179, p = .0), Social Influence (3.9%, b = .227, t = 4.078, p = .0) and Facilitating Conditions (0.6%, b = .111, t = 1.992, p = .048).

5. Discussion and Implications

The paper investigates the demographic characteristics of university students' perceptions towards their behavioral intention to adopt a mobile AR app in Greek malls. This is the first part of an ongoing study that aims to shed light on this contemporary topic. The results reveal that there are similarities as well as some differences between their perceptions based on the demographics. In specific, Performance Expectancy and Social Influence are the two variables that greatly influenced all examined groups regardless of their demographic characteristics. Regarding the Performance Expectancy, it seems that smartphone users anticipate that the app would help them decide more quickly about what to buy. The benefits of AR to provide additional information, such as more details about products, price comparison features, advertisements, guidelines and advice in the shopping mall, etc. are important and significantly affect their perceptions towards such an AR app. As regards to the Social Influence factor, it is generally accepted that people's opinion can influence others in various forms of everyday life. As a consequence, in this study, the results reveal that individuals, who are important to the respondents, such as friends and relatives, can greatly affect their perceptions towards AR apps. Hence, the positive or negative attitude of university students towards such an AR app is greatly based on their close environment.

Facilitating Conditions revealed that they influence only students who live in cities and towns and all university ranks apart from freshmen. Therefore, it seems that these groups of students believe that their smartphone already encompasses AR features and have the knowledge required to use such an AR app in a mall. Higher income from students who live in cities/ towns might be one reason why Facilitating Conditions impact on their perceptions towards the intention to adopt AR app for malls. Regarding freshmen, it came as a surprise why they differ from the rest of the students. Their inability to acquire such a smartphone and the lack of knowledge based on their age - few months after their high school graduation - possibly be the most important reasons why Facilitating Conditions factor was not confirmed. In any case, a further, detailed investigation is needed.

On the other side, despite the fact that the aforementioned results provide meaningful implications the research can be further improved by overtaking some important limitations. First, the enhancement of the UTAUT model with other variables suggested in relevant literature might provide a more thorough and comprehensive approach to the topic. This approach could be further enriched with the application of more advanced data analysis methods, such as Structural Equation Modeling (SEM), and thus, offer an even more tangible framework-model including the relationships of the examined variables with each other. Second, it is worth noting that these findings are limited to a sample of Greek university students. Hence, similar studies could be taken place to the rest of the Greek population and a larger group of university students, with the aim to acquire the data required for generalizing the results. Evidence from heterogeneous samples is definitely required to further investigate why Effort Expectancy was rejected, as well as make it even more clearer why the Facilitating Conditions factor was confirmed only to students with specific demographic characteristics on this study. Furthermore, analogous cross-cultural studies focusing on the different cultural aspects of the respondents could also be made in other countries, with a view to provide comparative data, which could be highly beneficial for the mobile AR app industry.

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