Applying UTAUT Model for an Acceptance Study Alluding the Use of Augmented Reality in Archaeological Sites

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Keywords: Acceptance of Technology, Augmented Reality in Archaeology, Cultural Heritage, UTAUT.

Abstract: Looking forward to enhance visitors' experience among cultural heritage sites, the use of new technologies within these spaces has seen a fast growth among the last decades. Regarding the increasing technological developments, the importance of understanding the acceptance of technology and the intention to use it in cultural heritage sites, also arises. The existing variety of acceptance models found in literature relatively to the use of technology, and the uncertainty about selecting a suitable model, sparked this research. Accordingly, the current study aims to select, evaluate and analyse an acceptance model, targeted to understand the behavioural intention to use augmented reality technology in archaeological sites. The findings of this research revealed UTAUT as a suitable model. However, regarding the collected data, some moderators' impact presented in the original study may change significantly. In addition, more constructs can be considered for wider understandings.

1 INTRODUCTION

The use of technologies within cultural heritage sites has been prospected in the last decades aiming to better fulfil visitors' expectations. The implementation of a new given technology among cultural heritage sites differs depending on the sort of space itself. The current study swell on archaeological spaces, regarding to their nature of being outdoors environments, usually with scarce access to technological solutions for exploring these environments.

Due to the technological developments among the last few decades, people are now allowed to access technology almost everywhere, through handy devices such as smartphones or tablets. Accordingly, some technological solutions, *inter alia*, Augmented Reality (AR), can be experienced in archaeological spaces, as long as, visitors have the interest and the conditions to do so.

In order to understand users' behaviour regarding the use of AR in archaeological sites, a literature review is made, and an acceptance of technology study is presented in the current study. Aiming to identify a suitable model to evaluate the use of this technology for archaeological sites, this study checks the effectiveness of a given theoretical model to understand users' perspective.

A vast diversity of models and theories have been proposed by researchers, looking forward to understand individuals' behaviour in different contexts. Thus, researchers have been improving these proposals combining them and, thereby, formulating new models, in order to find better solutions for each area of work.

Considering the use of AR in archaeological sites, the available models of the acceptance of technology were analysed and the Unified Theory of Acceptance and Use of Technology (UTAUT) was selected. Accordingly, the current study presents a review of models and theories related to acceptance of technology studies, as well as, implements UTAUT model to understand user's behaviour regarding to the use of AR in archaeological sites.

2 STATE OF THE ART

This literature review is divided in two main topics: 1) an overview related to the most common models proposed to evaluate the acceptance and intention to use technology, and 2) a scope of previous studies regarding to their choices considering the available models in the literature.

Marto, A., Gonçalves, A., Martins, J. and Bessa, M.
Applying UTAUT Model for an Acceptance Study Alluding the Use of Augmented Reality in Archaeological Sites.
DOI: 10.5220/0007364101110120
In *Proceedings of the 14th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2019)*, pages 111-120
ISBN: 978-989-758-354-4

2.1 Acceptance of Technology Models

Trying to comprehend users' acceptance and intention to use technologies, a variety of models and theories have been developed in order to unravel this relation between users and technology. An understanding related to the adoption of behaviours has been provided by the Theory of Reasoned Action (Fishbein, 1979; Ajzen and Fishbein, 1980). The authors stated that measuring the behavioural intention, it is possible to predict the performance of any voluntary act.

Building on this model, which has been largely used among the years to predict behavioural intentions, one of the most substantial and influential theories of human behaviour, the Technology Acceptance Model (TAM), was developed (Davis, 1986). This model describes the motivational process mediating system characteristics and user behaviour, and relating individual choices when adopting or not a technology when performing a task. For this analysis, measures related to characteristics of the system and capabilities, are made in order to relate it with users' motivation to use the system, which can affect their actual system use or non-use. A theoretical extension of TAM was presented as TAM 2 (Venkatesh and Davis, 2000) which included additional theoretical constructs embracing social influence processes and cognitive instrumental processes. This acceptance model covers the evaluation of constructs such as perceived usefulness, perceived ease of use, intention to use, and the actual usage behaviour. TAM 3 (Venkatesh and Bala, 2008) come out from the combination of TAM 2 with the model of the determinants of perceive of use, creating new relationships, focused on interventions regarding potential pre- and post-implementations.

Despite the large number of studies conducted aiming to understand factors that contribute to successful implementations of technology, DeLone and McLean looked at information system success as unachievable. Thus they proposed the DeLone and McLean (D&M) Information Systems (IS) Success Model as a framework and model for measuring the complex-dependent variable in IS research, through six categories: system quality, information quality, use, user satisfaction, individual impact, and organizational impact (DeLone and McLean, 1992). This model was updated in 2003 attempting to capture the multidimensional and interdependent nature of IS success (DeLone and McLean, 2003). Service Quality was added and stated as an important dimension of IS success given the importance of IS support, especially in the proposed case study: e-commerce environment.

Consistent with DeLone and McLean proposal in 1992, a model called the Technology-to-Performance Chain was proposed in 1995 (Goodhue et al., 1995). This approach stresses the linkage between constructs, reflecting the impact of information technology on performance. The importance of a construct known as Task-Technology Fit (TTF) on performance impacts is highlighted. TTF models explicitly include task characteristics, as the examples proposed in the Technology-to-Performance Chained, implying the matching of capabilities of the technology with the demands of the task. A common addition to TTF models are individual abilities, such as computer literacy, where its perceive can be negatively affected between task and technology (Goodhue, 1995).

Among new approaches, which have been blended several models and theories striving for proposing new and more suitable models to better understand the acceptance of technology, it is found a clear example of these combinations: the Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by Venkatesh *et al.* in 2003 (Venkatesh et al., 2003). This proposal unified eight theories and models of individual acceptance, namely, the Theory of Reasoned Action (proposed in 1988), TAM (described above), Motivational Model (proposed in 1992), Theory of planned Behaviour (proposed in 1991), Combined TAM and Theory of Planned Behaviour (1995), Model of PC Utilisation (proposed in 1977), Innovation Diffusion Theory (1995), and Social Cognitive Theory (proposed in 1986). In their approach, they pointed out four constructs registered as significant to determine the behaviour intention of individuals to use a technology: performance expectancy, effort expectancy, social influence, and facilitating conditions. These constructs were associated with individual differences – age, gender, voluntariness, and experience – as moderators on behavioural intention to use a technology. The UTAUT 2, presented in 2012 (Venkatesh et al., 2012), provided three new constructs, namely, hedonic motivation, price value, and habit.

2.2 Acceptance of Technology Case Studies

The applicability of these models and theories has been a subject of study in order to accomplish a more accurate evaluation related to the degree of acceptance and, hence the use of technology in diverse acting areas.

Considering some recent and relevant studies, in 2010, Usoro *et al.* combined TAM and TTF to explore the user acceptance and use of tourism e-commerce

websites (Usoro et al., 2010). The UTAUT 2 model was used to understand online purchase intentions and actual online purchases (Escobar-Rodríguez and Carvajal-Trujillo, 2014). The usage of AR for education was apprehended using the TAM model (Ibáñez et al., 2016). The users' acceptance and use of AR mobile application in Meleka – tourism sector – was evaluated using the UTAUT model (Shang et al., 2017). The behavioural intention to use virtual reality in learning process was evaluated proposing the UTAUT model (Shen et al., 2017). A study for acceptance of AR application within the urban heritage tourism context in Dublin, proposed the TAM model (tom Dieck and Jung, 2018).

Regarding to cultural studies, the understanding of cultural factors is important to highlight since they play a significant role, praising the necessity to consider cultural aspects as influent elements. Cultural moderators were taken into account among several studies related to acceptance and use of technology (e.g., (Tam and Oliveira, 2017), (Venkatesh et al., 2016)). Others, specifically target to ascertain cultural differences, such as (Ashraf et al., 2014) and (Tarhini et al., 2015), which helps to understand how different cultures react differently to the same proposals.

The acceptance of each technology may require specific requirements for its study. Therefore, a focused study regarding to the acceptance of augmented reality in heritage contexts was made (from 2012 up to now) and, the list of found results, hitherto, is not very extensive. Table 1 presents some of the acceptance studies accomplished, The acceptance model used and the sample size are specified. Questionnaires were the evaluation instrument used in all shown studies. An exception was found in one study (tom Dieck and Jung, 2018), which used one-to-one interviews as an evaluation instrument.

Regarding the results presented in table 1, TAM model was the most common model used by researchers. UTAUT (or UTAUT 2) and DeLone & McLean's are also frequent choice. Sample sizes, when present, are between 44 and 241 participants.

Table 1: Previous acceptance of augmented reality technology studies found, from 2012 until now.

Context	Model	Sample	Reference
AR in Cultural Heritage	TAM	200 + 42	(Haugstvedt and Krogstie, 2012)
AR interactive technology to enable consumers to try on clothes online	TAM	220	(Huang and Liao, 2015)
AR in natural park	D&M	241	(Jung et al., 2015)
AR for tourism: destinations and attractions	TAM	(not found)	(Chung et al., 2015)
AR Travel Guide	UTAUT2	105	(Kourouthanassis et al., 2015)
AR for education: help engineering students to solve problems	TAM	122	(Ibáñez et al., 2016)
Mobile AR app to show campus-related information on a map	UTAUT + D&M	(not found)	(Alqahtani and Kavakli, 2018)
AR in urban heritage tourism	TAM	44	(tom Dieck and Jung, 2018)

3 ACCEPTANCE MODEL ADOPTION

To understand individuals' acceptance of augmented reality technology among archaeological sites, UTAUT model was implemented and a questionnaire was created. In this section, the variables in study, hypotheses and the results obtained are presented.

3.1 Acceptance Model Selection

The knowledge related to the most significant acceptance models presented in the previous chapter allowed to select an acceptance model to suit the case of study of this research. Since the requirements of this study to seek a prediction of behaviours, where participants have no access to experience a prototype, the unified theory of acceptance and use of technology (UTAUT) and its constructs related with expected behaviours, seemed to better fit this study needs. The new constructs proposed for UTAUT 2 appeared to be misplaced because the current case study is not focused in commerce.

Therefore, the constructs and respective items are described bellow, as well as, the moderators considered.

The independent variables (IV) evaluated in the current study are Performance Expectancy (PE), Ef-

fort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC). The dependent variable (DV) is Behavioural Intention (BI). For each variable several items in the questionnaire were presented through a Likert-type scale classifying the level of agreement, from *1 - strongly disagree*, to *7 - strongly agree*.

3.1.1 Performance Expectancy

Venkatesh *et al.* defined Performance Expectancy (PE) as the degree to which a person believes that using the system will help each individual to obtain gains related to something. In the original model, these gains were related to job performance (Venkatesh et al., 2003).

The items used to evaluate PE in the current study were the following:

PE.1 Using augmented reality may help me get more information about the archaeological space.

PE.2 Using augmented reality may help me get information about the archaeological space more quickly.

PE.3 Using augmented reality may increase my interest in archaeological spaces.

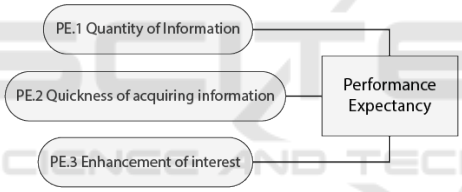

Figure 1: Graphic representation of the items used to evaluate performance expectancy for the current study.

Figure 1 summarizes the items used to evaluate PE, specifically, quantity of information, quickness of acquiring information, and enhancement of interest for archaeological spaces.

3.1.2 Effort Expectancy

Venkatesh *et al.* defined Effort Expectancy (EE) as the degree of ease associated with the use of the system (Venkatesh et al., 2003).

The items used to evaluate EE in the current study were the following:

EE.1 I think that augmented reality is easy to use.

EE.2 I think that my interaction with augmented reality will be clear and understandable.

EE.3 It will be easy for me to become skilful at using augmented reality.

Figure 2 summarizes the items used to evaluate the independent variable EE, specifically, ease of use, clearness of interaction, and ease to become skillful in using AR.

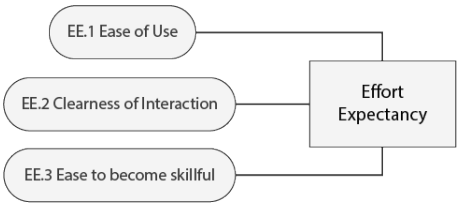

Figure 2: Graphic representation of the items used to evaluate effort expectancy for the current study.

3.1.3 Social Influence

Venkatesh *et al.* defined Social Influence (SI) as the degree to which a person perceives that important others believe each individual should use the new system (Venkatesh et al., 2003).

The items used to evaluate SI in the current study were the following:

SI.1 People that are important to me (e.g. family and friends) think that I should use augmented reality.

SI.2 I am more likely to use augmented reality if people that are important to me use it as well.

SI.3 I am more likely to use augmented reality if people around me use it as well.

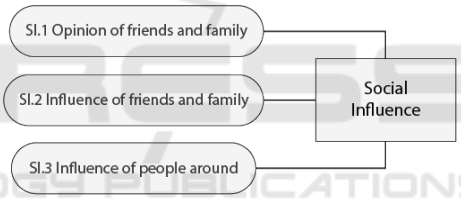

Figure 3: Graphic representation of the items used to evaluate social influence for the current study.

Figure 3 summarizes the items used to evaluate the independent variable SI, specifically, opinion of friends and family, influence of friends and family, and influence of people around.

3.1.4 Facilitating Conditions

Venkatesh *et al.* defined Facilitating Conditions (FC) as degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system (Venkatesh et al., 2003).

The items used to evaluate FC in the current study were the following:

FC.1 I have the resources necessary to use augmented reality (e.g. smartphone).

FC.2 I have the necessary knowledge to use augmented reality.

FC.3 Augmented reality is compatible with other technologies I use.

FC.4 I can get help from others if I have difficulties using augmented reality.

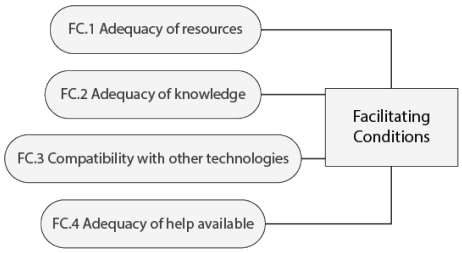

Figure 4: Graphic representation of the items used to evaluate facilitating conditions for the current study.

Figure 4 summarizes the items used to evaluate the independent variable FC, specifically, adequacy of resources to use AR technology, adequacy of knowledge, compatibility with other technologies, and adequacy of help available.

3.1.5 Behavioural Intention

According to Venkatesh *et al.*, it is expected that Behavioural Intention (BI) will have a significant positive influence on technology usage (Venkatesh et al., 2003).

The items used to evaluate this dependent variable in the current study were the following:

BI.1 I would like to use augmented reality in archaeological spaces as soon as possible.

BI.2 I plan to use augmented reality applied to archaeological sites in the future.

BI.3 I will always try to use augmented reality when visiting archaeological sites.

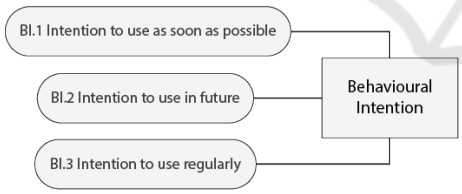

Figure 5: Graphic representation of the items used to evaluate behavioural intention for the current study.

Figure 5 summarizes the items used to evaluate the independent variable BI, specifically, intention to use as soon as possible, intention to use in future and, intention to use it regularly.

3.2 Moderators

Regarding the UTAUT constructs, participants of the current study, were asked to choose between male and female options and to specify their age.

For this study, the stages of experience presented in UTAUT original model, was converted Technological Knowledge. This moderator is evaluated by each participant who classify themselves their level of knowledge related to how to use augmented reality through a 7 point Likert-scale, from *1 (very bad)* to *7 (very good)*.

Voluntariness of Use was dropped because the use of augmented reality in archaeological spaces is intended to be an optional feature for visitors. Thus, it is assumed that the voluntariness of use will be always given state.

A new moderator was added considering the Archaeological Knowledge, which is evaluated by each participant who classify themselves their level of knowledge through a 7 point Likert-scale, from 1 (very bad) to 7 (very good).

3.3 Formulation of Hypothesis

The current study will use the hypothesis raised in the unified theory presented by Venkatesh *et al.* (Venkatesh et al., 2003), adapting the moderators to the existing hypothesis. Thus, besides age and gender, archaeological knowledge and technological knowledge are considered in the following hypothesis:

PE.H1: The influence of performance expectancy on behavioural intention will be moderated by age, gender, archaeological knowledge and technological knowledge, such that the effect will be stronger for men, particularly for younger men, for higher archaeological connoisseurs and for higher technology connoisseurs.

Figure 6 illustrates this relation.

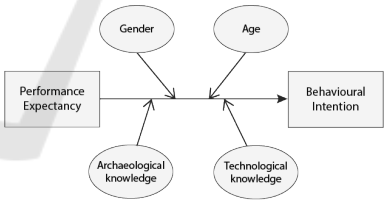

Figure 6: Graphic representation of the hypothesis PE.H1.

Regarding to effort expectancy, the hypothesis raised by Venkatesh *et al.* (Venkatesh et al., 2003) was tailored to the following:

EE.H2: The influence of effort expectancy on behavioural intention will be moderated by age, gender, and technological knowledge, such that the effect will be weaker for man, particularly younger man, and particularly for higher technology connoisseurs.

Figure 7 illustrates this relation.

Regarding to social influence, the literature suggests that women tend to be more sensitive to others' opinion, affecting their intention to use new technology (Venkatesh, 2000). Accordingly, the on going hypothesis is defined as follows:

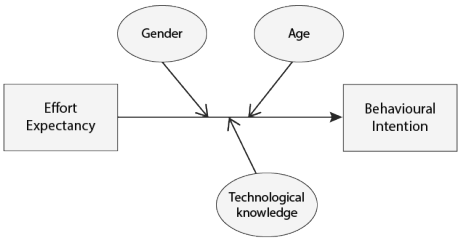

Figure 7: Graphic representation of the hypothesis EE.H2.

SI.H3: The influence of social influence on behavioural intention will be moderated by age, gender, and technological knowledge, such that the effect will be stronger for women, particularly older women, and particularly for lower technology connoisseurs.

Figure 8 illustrates this relation.

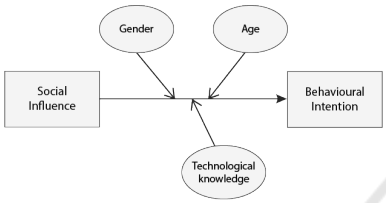

Figure 8: Graphic representation of the hypothesis SI.H3.

Regarding the facilitating conditions presented in UTAUT model, where it was stated as an hypothesis that FC will not have a significant influence on behavioural intention, for the current study a relation is proposed, as it was updated in UTAUT2 (Venkatesh et al., 2012) and as resulted as following.

FC.H4: The influence of facilitating conditions on behavioural intention will be moderated by age, gender and technological knowledge, such that the effect will be stronger for man, particularly younger man, and particularly with high levels of technological knowledge.

Figure 9 illustrates the relation created between FC and the BI, considering the moderators age and experience.

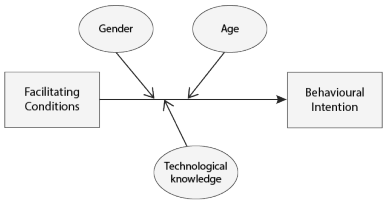

Figure 9: Graphic representation of the hypothesis FC.H4.

Considering the hypothesis raised in UTAUT2, related to the impact of behavioural intention being moderated by experience, this relation was adjusted aiming to detect if age, gender, archaeological knowledge and, technological knowledge would moderate the behavioural intention to use AR technology. Accordingly, the hypothesis raised is the following:

BI.H5: The behavioural intention will be moderated by age, gender, archaeological knowledge and technological knowledge, such that the effect will be stronger for men, particularly for younger men, for higher archaeological connoisseurs, and for higher technology connoisseurs.

Table 2 resumes the relations created between constructs and moderators, based on aforementioned hypothesis.

Table 2: Summary of the hypothetical relations between moderators and constructs.

IV	**Moderators**	**DV**	**Hypothetical Scenario**
PE	Age, Gender, Archaeological knowledge, Technological knowledge	BI	Stronger for younger men, with higher levels of archaeological and technological knowledge
EE	Age, Gender, Technological knowledge	BI	Weaker for younger men with high technological knowledge
SI	Age, Gender, Technological knowledge	BI	Stronger for older women with lower technological knowledge
FC	Age, Gender, Technological knowledge	BI	Stronger for younger men with high technological knowledge
BI	Age, Gender, Archaeological knowledge, Technological knowledge,		Stronger for younger men, with higher levels of archaeological and technological knowledge

4 RESULTS

A pre-test was carried out with a total of 31 answers obtained in an archaeological space, in particular, within the Roman Ruins of the Museu Monográfico de Conimbriga-Museu Nacional (Portugal). Based on participants feedback while answering the questionnaires, a time estimation to answer the entire questionnaire was stipulated, as well as, some adjustments related to the reading interpretation of the questions were made.

The current study collected a total of 166 participants, whom answered an online questionnaire, between August and October 2018. The sample was

composed by 42.2% female and 57.8% male. Among this heterogeneous group of participants, 61.7% of them are between 17 and 30 years old, 22.2% are between 31 and 40 years old, 11.4% are between 41 and 50 years old, and 4.8% are more than 50 years old.

4.1 Correlations: Independent Variables and the Behavioural Intention Items

Correlations of Kendall's coefficient between the different items which defines each construct were created. These non parametric correlations are displayed in the following tables.

The abbreviation "C.C." displayed thereafter stands for Correlation Coefficient [1], and "Sig." corresponds to Significance Test (2-tailed).

The correlations between PE items (IV) and BI (DV) items, are shown in table 3. Table 4 displays the correlations between EE items and BI items. Correlations between SI and BI are visible in table 5, while FC correlations with BI items are presented in table 6.

Table 3: Correlations found between PE and BI items.

	BI.1		BI.2		BI.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
PE.1	.476**	.000	.497**	.000	.365**	.000
PE2	.432**	.000	.425**	.000	.336**	.000
PE.3	.382**	.000	.400**	.000	.437**	.000

** Correlation is significant at the 0.01 level (2-tailed)

Significant strong positive correlation were found between PE and BI items (table 3). The stronger correlation identified, with a coefficient of 0.497, was between Quantity of information (PE.1) and Intention to use in future (BI.2), followed by other strong correlations, such as between Quantity of information (PE.1) and Intention to use as soon as possible (BI.1), and between Quickness of acquiring information (PE.2) and Intention to use as soon as possible (BI.1).

Significant strong positive correlation were also found between EE and BI items (table 4). The stronger correlation identified, with a coefficient of 0.421, was between Ease to become skillful (EE.3) and Intention to use in future (BI.2), followed by correlations between Clearness of Interaction (EE.2) with both items: Intention to use as soon as possible (BI.2), and Intention to use regularly (BI.3).

[1]Correlations measure the relationship between two variables which can vary between -1 and 1. A zero value means there is no correlation between those variables. The closer a correlation is to 1 or -1, the stronger the relationship is between variables. A negative correlation (closer to -1) represents a stronger effect for the lower value. A positive correlation (closer to 1) represents a stronger effect for the higher value).

Table 4: Correlations found between EE and BI items.

	BI.1		BI.2		BI.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
EE.1	.302**	.000	.326**	.000	.242**	.000
EE.2	.361**	.000	.388**	.000	.377**	.000
EE.3	.374**	.000	.421**	.000	.310**	.000

** Correlation is significant at the 0.01 level (2-tailed)

Table 5: Correlations found between SI and BI items.

	BI.1		BI.2		BI.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
SI.1	.312**	.000	.260**	.000	.271**	.000
SI.2	.151*	.015	.118	.060	.144*	.019
SI.3	.173**	.005	.195**	.002	.180**	.004

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Less significant strong positive correlation were found between SI and BI items (table 5). The SI item which appears to have strong correlations with all three BI items is related with Opinion of friends and family (SI.1).

Table 6: Correlations found between FC and BI items.

	BI.1		BI.2		BI.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
FC.1	.082	.215	.137*	.042	.216**	.001
FC.2	.194*	.002	.247**	.000	.262**	.000
FC.3	.259**	.000	.279**	.000	.278**	.000
FC.4	.190**	.003	.214**	.001	.248**	.000

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Despite less strong when compared with PE and EE items, the correlations found between FC items and BI are also significant strong and positive (table 6). Stronger correlations disclosed with BI items are related to Compatibility with other technologies (FC.3).

4.2 Correlations: Moderators and Constructs

Regarding the aforementioned hypothesis, correlations between moderators and PE items are shown in table 7. Table 8 displays the correlations between EE items and its moderators. Correlations between

SI and its moderators are visible in table 9, while FC correlations with respective moderators items are presented in table 10. BI correlations with its moderators, can be observed in table 11.

The abbreviation "A.K." displayed thereafter stands for Archaeological Knowledge, and "T.K." corresponds to Technological Knowledge. Regarding gender analysis, to interpret these correlations, its allocation is important to specify: value 1 was set for males, and value 2 for females.

Table 7: Correlations found between moderators and PE items.

	PE.1		PE.2		PE.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
Age	.068	.265	.011	.855	-.018	.764
Gender	-.052	.473	-.003	. 964	-.050	. 478
A.K.	.158*	0.15	.091	.158	.151*	.017
T.K.	.314**	.000	.213**	.001	.157*	.012

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

No significant correlations were found regarding to age and PE (table 7). Significant positive strong correlations for archaeological knowledge and for technological knowledge, were found being stronger in this last moderator.

Table 8: Correlations found between moderators and EE items.

	EE.1		PE.2		EE.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
Age	.041	.487	.009	.874	.056	.345
Gender	-.092	.190	-.103	.144	-.219**	.002
T.K.	.397**	.000	.358**	.000	.341**	.000

** Correlation is significant at the 0.01 level (2-tailed)

No significant correlations were found regarding to age and EE (table 8). A significant negative strong correlation is found between gender and EE.3, revealing that this correlation is stronger for males. Significant positive strong correlations for technological knowledge for all EE items.

No significant correlations were found regarding to age and SI items (table 9). A significant negative strong correlation is found between gender and two SI items (SI.1 and SI.2), revealing a stronger relation among males. Technological knowledge has a significant strong correlation with one SI item, namely, SI.1 (Opinion of friends and family).

No significant correlations were found regarding to age and FC items (table 10). A significant negative strong correlation is found between gender and

Table 9: Correlations found between moderators and SI items.

	SI.1		SI.2		SI.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
Age	.002	.978	-.048	.400	-.064	.263
Gender	-.162*	.021	-.094	.169	-.136*	.048
T.K.	.202**	.001	-.020	.742	.030	.622

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 10: Correlations found between moderators and FC items.

	FC.1		FC.2		FC.3		FC.4	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
Age	-.039	.526	.015	.795	.057	.330	.011	.855
Gender	-.073	.317	-.291**	.000	-.207**	.003	-.099	.157
T.K.	.258**	.000	.623**	.000	.455**	.000	.276**	.000

** Correlation is significant at the 0.01 level (2-tailed)

FC.2, and FC.3, revealing a stronger relation among males to these two items. Technological knowledge has a significant positive strong correlation with all FC items, notably for FC.2.

Table 11: Correlations found between moderators and BI items.

	BI.1		BI.2		BI.3	
	C.C.	*Sig.*	*C.C.*	*Sig.*	*C.C.*	*Sig.*
Age	.015	.805	.094	.118	.015	.795
Gender	-.044	.533	-.116	.104	-.080	.253
A.K.	.205**	.001	.228**	.000	.194**	.002
T.K.	.205**	.001	.246**	.000	.238**	.000

** Correlation is significant at the 0.01 level (2-tailed)

No significant correlations were found regarding to age neither to gender and BI items (table 11). Archaeological and technology knowledge are moderators found to have significant positive correlations with all BI items.

4.3 Bridging Results and Hypothesis

The given results revealed that the hypothesis are not entirely true regarding the use of augmented technology in archaeological sites.

Accordingly, in PE.H1, the influence of performance expectancy on behavioural intention is not moderated by gender neither by age, but is moderated by archaeological knowledge and technological knowledge, such that the effect is stronger for higher archaeological connoisseurs, and for higher technology connoisseurs.

Observing EE.H2, the presented results allow to state that the influence of effort expectancy on be-

havioural intention is not moderated by age, but is moderated by gender and by technological knowledge, such that the effect is weaker for male, and particularly for higher technology connoisseurs.

Regarding to SI.H3, the collected data permit to affirm that influence of social influence on behavioural intention is not moderated by age, but is moderated by gender and by technological knowledge, such that the effect is stronger for men, and particularly for lower technology connoisseurs.

From FC.H4, the presented results, allow to state that the influence of facilitating conditions on behavioural intention is not moderated by age, but is moderated by gender and technological knowledge, such that the effect will be stronger for man, particularly with high levels of technological knowledge.

While analysing BI.H5 hypothesis, it is possible to state that behavioural intention is not moderated by gender neither by age, but is moderated by archaeological knowledge and by technological knowledge, such that the effect will be stronger for higher archaeological connoisseurs and, for higher technology connoisseurs.

5 CONCLUSIONS

The current study aimed to identify a suitable acceptance model for evaluating the behavioural intention to use augmented reality technology in archaeological spaces.

Hypothesis based on UTAUT model, with some particular features covered in UTAUT2 model, and some adjustments regarding the case study are presented. Moderators were also tested, dropping voluntariness of use, converting experience to technological knowledge, and adding archaeological knowledge.

The results obtained, through online questionnaires, in a total of 166 valid answers for all questions, revealed that the behavioural intention to use AR in archaeological sites is influenced by performance expectancy, effort expectancy, social influence, and facilitating conditions.

However, significant changes in the raised hypothesis were observed regarding the moderators. The collected data demonstrated that, for the use of AR in archaeological sites, age does not play a role as moderator to any construct analysed. Gender also missed some relevance in some constructs, such as performance expectancy and behavioural intention.

These findings confirm that 1) UTAUT model as a suitable model for understanding the behavioural intention to use AR, but also emphasize a second outcome, 2) the importance of holding continuous acceptance studies to keep up-to-date new technologies understandings. Regarding the interest of implementing this technology in archaeological spaces, a deeper model should be applied to actual visitants, including more constructs for wider understandings, as well as, statistical studies regarding the prediction of results, should also being accomplished.

Thus, this proposed model should be supplemented with more variables in order to better understand the acceptance and intention to use a new technology, such as AR in archaeological sites. Despite the fact that UTAUT model was shown as a suitable model for understanding the behavioural intention to use AR, it can be refined with the addition of variables stemming from other models or/and theories. Accordingly, a deepen research related to the integration of new variables must be accomplished followed by a new experimental evaluation.

ACKNOWLEDGEMENTS

This work is financed by the ERDF – European Regional Development Fund through the Operational Programme for Competitiveness and Internationalisation - COMPETE 2020 Programme and by National Funds through the Portuguese funding agency, FCT - Fundação para a Ciência e a Tecnologia within project POCI-01-0145-FEDER-031309 entitled “PromoTourVR - Promoting Tourism Destinations with Multisensory Immersive Media.

REFERENCES

Ajzen, I. and Fishbein, M. (1980). Understanding attitudes and predicting social behaviour. *Prentice-Hall*.

Alqahtani, H. and Kavakli, M. (2018). A Theoretical Model to Measure User’s Behavioural Intention to Use iMAP-CampUS App. In *12th IEEE Conference on Industrial Electronics and Applications (ICIEA)*, pages 681–686, Siem Reap, Cambodia. IEEE.

Ashraf, A. R., Thongpapanl, N., and Auh, S. (2014). Acceptance Model Under Different Cultural Contexts: The Case of Online Shopping Adoption. *Journal of International Marketing*, 22(3):68–93.

Chung, N., Han, H., and Joun, Y. (2015). Tourists’ Intention to Visit a Destination: The Role of Augmented Reality (AR) Application for a Heritage Site. *Computers in Human Behavior*, 50:588–599.

Davis, F. D. (1986). *A Technology Acceptance Model for Empirically Testing New End-User Systems: Theory and Results*. PhD thesis, MIT.

DeLone, W. H. and McLean, E. R. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, 3(1):60–95.

DeLone, W. H. and McLean, E. R. (2003). The DeLone and McLean Model of Information Systems Success. *Journal of Management Information Systems*, 19(4):9–30.

Escobar-Rodríguez, T. and Carvajal-Trujillo, E. (2014). Online purchasing tickets for low cost carriers: An application of the unified theory of acceptance and use of technology (UTAUT) model. *Tourism Management journal*, 43:70–88.

Fishbein, M. (1979). A theory of reasoned action: Some applications and implications.

Goodhue, D. L. (1995). Understanding User Evaluations of Information Systems. *Management Science*, 41(12):1827–1844.

Goodhue, D. L., Thompson, R. L., and Goodhue, B. D. L. (1995). Task-Technology Fit and Individual Performance. *Mis Quarterly*, 19(2):213–236.

Haugstvedt, A.-C. and Krogstie, J. (2012). Mobile Augmented Reality for Cultural Heritage: A Technology Acceptance Study. In *Proceedings of the IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, pages 247–255, Atlanta, GA, USA.

Huang, T.-L. and Liao, S. (2015). A model of Acceptance of Augmented-Reality Interactive Technology: the Moderating Role of Cognitive Innovativeness. *Electronic Commerce Research*, 15(2):269–295.

Ibáñez, M.-B., Serio, Á. D., Villarán, D., and Delgado-Kloos, C. (2016). The Acceptance of Learning Augmented Reality Environments: A Case Study. In *Proceedings of the 16th International Conference on Advanced Learning Technologies (ICALT)*, pages 307–311.

Jung, T., Chung, N., and Leue, M. C. (2015). The Determinants of Recommendations to Use Augmented Reality Technologies: The Case of a Korean Theme Park. *Tourism Management*, 49:75–86.

Kourouthanassis, P., Boletsis, C., Bardaki, C., and Chasanidou, D. (2015). Tourists Responses to Mobile Augmented Reality Travel Guides: The Role of Emotions on Adoption Behavior. *Pervasive and Mobile Computing*, 18:71–87.

Shang, L. W., Siang, T. G., bin Zakaria, M. H., and Emran, M. H. (2017). Mobile augmented reality applications for heritage preservation in UNESCO world heritage sites through adopting the UTAUT model. In *Proceedings of the AIP Conference*, volume 1830. American Institute of Physics Articles.

Shen, C.-w., Ho, J.-t., and Kup, T.-C. (2017). Behavioral Intention of Using Virtual Reality in Learning. In *Proceedings of the International World Wide Web Conference Committee*, pages 129–137. Creative Commons CC.

Tam, C. and Oliveira, T. (2017). Understanding mobile banking individual performance: The DeLone & McLean model and the moderating effects of individual culture. *Internet Research*, 27(3):538–562.

Tarhini, A., Hone, K., and Liu, X. (2015). A Cross-cultural Examination of the Impact of Social, Organisational and Individual Factors on Educational Technology Acceptance Between British and Lebanese University Students. *British Journal of Educational Technology*, 46(4):739–755.

tom Dieck, M. C. and Jung, T. (2018). A theoretical model of mobile augmented reality acceptance in urban heritage tourism. *Current Issues in Tourism*, 21(2):154–174.

Usoro, A., Shoyelu, S., and Kuofie, M. (2010). Task-Technology Fit and Technology Acceptance Models Applicability to e-Tourism. *Journal of Economic Development, Management, IT, Finance and Marketing*, 2(1):1–32.

Venkatesh, V. (2000). Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. *Information System Research*, 11(4):342–365.

Venkatesh, V. and Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences*, 39(2):273–315.

Venkatesh, V. and Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. 46(2):186–204.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27:425–478.

Venkatesh, V., Thong, J. Y. L., and Xu, X. (2012). Consumer Aceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, 36(1):157–178.

Venkatesh, V., Thong, J. Y. L., and Xu, X. (2016). Unified Theory of Acceptance and Use of Technology: A Synthesis and the Road Ahead. *Journal of the Association for Information Systems*, 17(5):328–376.