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Research Paper: **A Theoretical Model of Mobile Augmented Reality Acceptance in Urban Heritage Tourism**

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ABSTRACT:

Latest mobile technologies have revolutionised the way people experience their environment. Recent research explored the opportunities of using augmented reality (AR) in order to enhance the user experience however, there is only limited research on users' acceptance of AR in the tourism context. The technology acceptance model is the predominant theory for researching technology acceptance. Previous researchers used the approach of proposing external dimensions based on secondary literature; however missed the opportunity to integrate context specific dimensions. This paper therefore aims to propose an AR acceptance model in the context of urban heritage tourism. Five focus groups, with young British female tourists visiting Dublin and experiencing a mobile AR application, were conducted. The data were analysed using thematic analysis and revealed seven dimensions that should be incorporated into AR acceptance research including information quality, system quality, costs of use, recommendations, personal innovativeness and risk as well as facilitating conditions.

Keywords: Augmented Reality, Technology Acceptance Model, Dublin AR, Urban Heritage Tourism

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in Urban Heritage Tourism**

Introduction

Latest mobile technologies have revolutionised the way people experience their environment. This development has led to the increased popularity of augmented reality (AR) applications to project augmented information on objects or users' immediate surroundings. Recent research explored the opportunities of using marker-based or GPS-based AR in order to enhance the overall tourism experience (Garau, 2014; Garau & Ilardi, 2014; Han, Jung & Gibson, 2014a; Jung, Chung & Leue, 2015; Kounavis, Kasimati & Zamani, 2012; Linaza, Guttierrez & Garcia, 2014; Rodríguez-Fino, Martin-Gutierrez & Meneses Fernqandez, 2013; Yovcheva, Buhalis & Hatzidis, 2014). However, to identify the potential of new technologies it is essential to examine user acceptance. A large number of user acceptance research adopted the technology acceptance model (TAM) in order to identify how new technological innovations are accepted.

The TAM has been applied to a number of different research disciplines whereby scholars generally adopted a positivistic point of view, extending the TAM with external variables identified solely from previous literature. However, Sun and Zhang (2006, p. 73) claimed the predominant use of quantitative techniques within TAM research and called for a 'methodological shift' in order to enhance the understanding of factors that might influence new technologies. This was supported by Baron, Patterson and Harris (2006), who recommended the use of more qualitative techniques in TAM research in order to get a deeper understanding of users' perception. In addition, Ayeh, Au and Law (2013) called for further TAM research examining context-specific external variables. This is particularly important in the light of researching the acceptance of AR, a technology that has not received much attention from previous scholars, thus potential external variables have not been thoroughly investigated beforehand. Finally, Leue, tom Dieck and Jung (2014) proposed a theoretical model of AR acceptance and identified external variables based on previous AR and mobile service acceptance literature and called for a qualitative investigation of potential external variables within the AR acceptance context. Therefore, the present study aims to take these recommendations on-board by qualitatively developing a TAM model.

This TAM study will focus on the acceptance of AR applications within the urban heritage tourism context in Dublin by using the young British female travellers market as an example. International tourism to Dublin has experienced a drastic decline over the last years (Failte Ireland, 2014a). Overall, Great Britain is the most important tourism market to the Republic of Ireland however, the devaluation of the British pound against the Euro after the financial crisis has affected young British travellers' destination choice due to the associated decrease in spending power (Team, 2008). In order to grow tourism, Dublin has the new aim to become a young and vibrant city which is competitive in the European market (Failte Ireland, 2014b). AR could be an important vehicle for driving the tourism industry into the direction of becoming a destination for young travellers. Therefore, the present study aims to contribute to the gap in the AR acceptance literature by qualitatively investigating and proposing an AR acceptance model applicable to the urban heritage tourism context using the young British female market.

To achieve this aim, this study presents a review of literature on AR in the urban heritage context, technology acceptance and AR acceptance. Moreover, five focus groups are analysed to identify context-specific constructs that influence AR acceptance in the urban heritage context using thematic analysis. This study will contribute to the current state of research by qualitatively proposing a TAM model which includes AR tourism-specific constructs. Findings are then discussed and theoretical as well as practical implications provided. Moreover, the model development will serve as a future reference point for academia and industry practitioners aiming to implement AR into the tourism experience.

Literature Review

Augmented Reality in Urban Heritage Tourism

Although research into the field dates back as early as the 1960's, technological limitations of all sorts have hindered the application of AR to anything beyond experimental research (Kounavis et al., 2012). The few exceptional cases of real life use have mostly been in highly specialised settings with a narrow field of use mostly for industrial uses (King, 2009). AR has only emerged since the debut of modern smartphones around 2007, which enabled precise location determination and featured components required for AR applications such as cameras, gyroscopes, solid state compasses and accelerometers (Haugstvedt & Krogstie, 2012).

The increased availability of AR applications provides destinations and tourism organisations with a possibility to utilise these applications in order to enhance the visitor experience (Han et al., 2014a; Jung et al., 2015; Linaza et al., 2014; Rodríguez-Fino et al., 2013; Yovcheva et al., 2013). According to Han et al. (2014a), AR applications provide tourists with the opportunity to get to know unknown surroundings in an enjoyable and interactive manner. Overall, these newly developed applications aim to offer tourists with interesting and valuable information in order to create an enjoyable tourist experience. AR gaming applications such as TimeWarp or Urban Sleuth have been created to actively engage its users through the reconstruction of historic events, buildings or by sending tourists on missions within a city or destination (Herbst, Braun, McCall & Broll, 2008). This enables tourists to learn about the history in an enjoyable manner which at the same time can serve for educational purposes and facilitate the learning process. Kouvanis et al. (2012) furthermore supported the value of using interactive content and blending computer generated content into the real world as information are provided in a different format than users' are used to hence, this novelty aspect captures attention and creates a unique visitor experience.

According to Jung and Han (2014), heritage sites are among the key sectors of tourism in the urban context. The International Council on Monuments and Sites (ICOMOS) or UNESCO are only few examples of organisations that aim to conserve monuments and sites worldwide. Being recognized as a UNESCO World Heritage Site creates strong awareness among tourists to visit a destination (Patuelli, Mussoni & Candela, 2013). Therefore, urban heritage as a subcategory of tourism has developed as a result of a number of influences on destinations, such as the economic impact due to reduced seasonality, expanded stays and expanded customer base (Chang, Milne, Fallon & Pohlmann, 1996; Patuelli et al., 2013). However, there are a number of negative impacts from urban heritage tourism regarding the use of space. Jung and Han (2014) pointed out that AR is an ideal solution to limit the negative effects of tourism on urban heritage destinations. Traditionally, the tourism experience in urban heritage sites was enhanced through signs or other information and content that affected the overall natural state of destinations. Nowadays, AR applications

allow the overlaying of digital content into the real environment preserving the original state of the side while allowing the tourist to see and receive information which enhances the experience (Kalay, Kvan & Affleck, 2007) and can help to enhance awareness of historic events or architecture (Garau, 2014). In addition, the possibility to provide three-dimensional content through AR makes information on cultural heritage accessible and understandable for non-expert tourists (Garau, 2014). Furthermore, according to Höllerer and Feiner (2004), AR provides tourists with a dynamic and interactive experience of culture and heritage with the potential to bring history to life. Garau (2014) supported the potential of AR through the creation of networks of cultural heritage sites, forming a new type of cultural tourism. Using this idea, AR can help to follow trails of heritage around a city, allowing tourists to explore destinations with a new level of engagement (Garau & Ilardi, 2014). Nevertheless, the full use of AR to enhance tourist experience in urban heritage tourism destinations has only received limited research (Han et al., 2014a).

Technology Acceptance

User acceptance of new technologies is an important indicator for a successfully implemented technology (Aldhaban, 2012). According to Wu et al. (2011), the TAM has been the predominant theory to examine technology acceptance since its development by Davis in 1986. Ayeh et al. (2013) acknowledged that the TAM is considered the most influential framework for addressing user acceptance. The TAM has its origin in the Theory of Reasoned Action (Fishbein & Ajzen, 1975) and incorporates users' attitudes and beliefs into the intention to adopt new technologies. Davis (1986) highlighted the importance of an exact undestanding why users accept or reject a technological innovation based on its perceived ease of use and perceived usefulness in order to avoid implementation failure. Over the years, the TAM has been adopted within a number of research disciplines including mobile services (Choi, Park & Park, 2011; Gao, Rohm, Sultan & Huang, 2012) and the tourism industry (Ayeh et al., 2013; Morosan, 2012; Parra-López et al., 2011) and more recently AR (Haugstvedt & Krogstie, 2012; Wojciechowsk & Cellary, 2013).

The identification of external variables for different research context is particularly important in order to account for different technological characteristics. This was supported by Ayeh et al. (2013), who identified the importance of using context-specific external variables within TAM research in order to ensure the applicability within given contexts. Early studies focusing on organisations' internal IT acceptance for instance acknowledged the importance of the external variable of social influence (Karahanna & Straub, 1999; Lucas & Spitler, 1999), while later studies focusing on consumers' e-commerce acceptance identified playfulness as one of external variables (Cheng, Sheen & Lou, 2006; Chang, 2010). Therefore, it is highly important to identify those external variables that are applicable to the context of AR.

Augmented Reality Acceptance

Overall, the development of AR is still in its infancy and although the technological requirements for compelling use cases of AR are now starting to be met, challenges do remain in terms of usability, accuracy and end user services (Han et al., 2014a; Olsson et al., 2012). Therefore, it is important to examine users' acceptance in order to ensure that AR application include functionalities that are accepted by its users. In addition, changes in the paradigms of what people see as computer and machine interaction pose new challenges as to the design of AR applications and devices. There has been significant interest in the field of AR from

numerous companies and academic scholars. While some approached the subject from a technological perspective focusing on the challenges and chances of hardware and software design (Livingston et al., 2013); others focused on the acceptance of the technology and the factors influencing people to use AR (Wojciechowsk & Cellary, 2013; Yussof et al., 2011). While previous research found clear indications that factors such as enjoyment (Haugstvedt & Krogstie, 2012; Wojciechowsk & Cellary, 2013), innovativeness (Yussof et al., 2011), perceived benefits and information quality (Olsson et al., 2012) amongst others influence the acceptance of AR, the challenges of user interface and hardware design are by no means solved or agreed on as to how they should be approached. While significant work has been done on smartphone based AR, further technological advances have enabled the development of other forms of AR. As Olsson et al. (2012) stated, current mobile devices ranging from digital cameras to navigators as well as mobile phones are becoming powerful platforms for AR. Taking into consideration further developments such as smart glasses and watches, the opportunities for AR for wearable computing are extending quickly.

Haugstvedt and Krogstie (2012) and Leue et al. (2014) supported the importance of enjoyment as an external variable within the AR acceptance context. The implementation of enjoyment as an external variable particularly increased with the emergence of online networks (Lee et al., 2012; Lin & Lu, 2011). Within the mobile service acceptance context, personal innovativeness (Zarmpou et al., 2012) as well as perceived benefits (Lopez-Nicolas et al., 2008) were confirmed to influence the behavioural intention to use. In addition, personal innovativeness, originally from the Diffusion of Innovation Theory (Rogers, 1962), has increasingly gained importance within TAM research (Gao et al., 2012; Yi et al., 2006). The Diffusion of Innovation Theory posits that three characteristics – compatibility, complexity, and relative advantage – influence users' acceptance or rejection of innovative technologies (Montazemi & Saremi, 2013). Olsson et al. (2012, p. 43) examined the perception of Finish early adopters regarding AR services and revealed that 'the most valuable mobile AR services were those demonstrating pragmatic usefulness for the user, e.g. by saving time and effort'. They concluded AR adopters desire rich and high quality information that are contextually relevant. The importance of the quality dimension within AR research has been supported by Jung et al. (2015). In addition, Olsson et al. (2012) revealed that AR applications should provide practical benefits that cannot be delivered through other forms of media. The above reviewed studies identified a number of external variables that are applicable to the AR acceptance context including enjoyment (Haugstvedt & Krogstie, 2012; Shin, 2007); personal innovativeness (Zarmpou et al., 2012); perceived benefits (Olsson et al., 2012); as well as information quality (Jung et al., 2015; Olsson et al., 2012).

Methods

Context of Study

This study took place in Dublin under the Dublin AR project initiated by Dublin City Council. Dublin aimed to utilise AR as an enhancement tool for tourists as well as to promote the city of Dublin as an urban heritage tourist destination. As part of the project, a smartphone-based AR application was developed in the context of Dublin's Heritage Trail. The Dublin AR application was marker based as well as GPS based and focused on specific elements of Dublin's Heritage Trail. The application included navigation functions as well as video, audio and text. The marker-based part of the application was tested in the General Post

Office, while the location-based part of the application was tested on O'Connor Street, part of Dublin Heritage Trail.

Data Collection

Overall, the aim of the present study was to identify factors affecting acceptance of mobile AR applications and propose an AR acceptance model in urban heritage tourism by adopting a qualitative approach. In order to gather in-depth information, five focus groups with 44 participants were conducted. According to Bader and Rossi (2001, p. 2), focus group is 'a special type of group interview that is structured to gather detailed opinions and knowledge about a particular topic from selected participants'. As stated by Gray (2009), the advantage of group interviews or focus groups over traditional one-to-one interviews is that this technique allows different opinions to emerge through a discussion among participants. Silverman (2011) furthermore emphasised that the strength of focus groups within qualitative research lies on the discussion among participants and the resulting richness of information. However, Hair, Money, Page and Samouel (2007, p. 198) revealed that due to the small size of focus groups they can only be considered 'discovery-oriented' and not representable for an entire population.

The participants for the focus groups were undergraduate students from England visiting Dublin as part of a field trip representing the young British female travellers' market. A non-probability sampling method was used by choosing all field trip participants. According to Tayie (2005), non-probability sampling, which does not follow a mathematical selection approach, is appropriate when data is collected from a readily accessible and voluntary group of participants such as students. In particular, this study looks at the female market and the participants' profile included 44 young British females. According to Venkatesh et al. (2000, p. 50), the role of gender is shaping the decision making process when it comes to new and innovative technologies and therefore it is considered useful to evaluate the acceptance behaviour individually. Furthermore, Lobo and Elaluf-Calderwood (2012) identified that young female users are an increasingly important market when it comes to new technological adoption.

The experiments and focus groups took place in Dublin on the fifth and sixth of November 2013. As part of the research, students experienced a GPS-based AR application in O'Connell Street, Dublin City as well as a marker-based application in the museum of the General Post Office in Dublin (Figure 1). Directly after the experiments, the focus groups were conducted. The five focus groups had eight to nine participants and ranged from sixteen to twenty-three minutes. The focus groups were conducted by a moderator to ensure that the researcher is not influencing participants (Wimmer & Dominick, 2013). The moderator conducting the data collection was fully aware of the subject, jargon and key issues (Krueger & Casey, 2014). Focus group questions asked about general perceptions of using the mobile AR application within Dublin, drawbacks and concerns, content specific questions, reasons to use the application as well as reasons to not use the application. Questions are shown in Table 1.

Please insert table 1 about here

Data Analysis

Thematic analysis was perceived to be the most appropriate technique in order to code the focus groups according to external dimensions and relevant sub-themes (Alholjailan, 2012).

The use of thematic analysis allows the researcher to form themes prior to the analysis while sub-themes are able to emerge during the process of analysing the data (Boyatzis, 1998). Codes have been developed after initially reviewing previous literature. For example, enjoyment (Haugstvedt & Krogstie, 2012; Shin, 2007) and personal innovativeness (Zarmpou et al., 2012) were found as relevant themes for the context of AR acceptance. The next step then included the revision of literature to identify appropriate sub-themes in order to generate a thematic-map (Boyatzis, 1998; Prayag & Ryan, 2011). Finally, an ongoing analysis of the focus group transcripts was conducted in order to identify existing themes and sub-themes as well as generate emerging themes and sub-themes (Prayag & Ryan, 2011).

Within the analysis, participants are referred to, for instance, F1P1 representing focus group 1 and participant 1. All focus groups had 9 participants except for Focus Group 1 which only had 8 participants.

Please insert Figures 1 about here

Findings

Table 2 presents the outcomes of the thematic analysis of the five focus groups. At the end of each section, propositions are being made for the development of the AR acceptance model.

External Dimensions

Dimension One – Information Quality

Themes relating to information quality appeared within the focus group analysis with a number of participants from every group talking about the importance of gathering information through the AR application, the need for instant and up-to-date information, relevance as well as attractiveness of the provided information. F2P3 pointed out that 'it would actually give you a bit more information than what was given to you in reality, so that was a plus'. The importance of the gathering of additional information was confirmed by F1P6 pointing out that the AR application 'is similar to Google Maps, but… provides just a bit more information for tourists especially'. Furthermore, the importance of instant and up-to-date information was supported by a number of participants. F3P3 for instance identified 'if you could call up like restaurants and their menus and prices and that sort of thing before you would go inside'. Also, F4P1 identified that 'if you are actually walking around and scanning things you get more information on things that aren't there'. Thus, enhancing tourists' immediate surroundings with digital content was considered as an important aspect of tourists' experience (Han et al., 2014a; Olsson et al., 2012). F5P4 furthermore added that 'it would be good if you can put in where you stand or if you can log in your hotel and it would give you notifications'.

Kaplan and Haenlein (2010) revealed that businesses should create attractive content in order to enhance engagement. This was confirmed within the focus groups as the attractiveness of information was mentioned as an important aspect of user experience. F4P5 stated that 'it was good that when you were inside [the museum] one of them was a video, one of them was a picture, and the other one was just text…it was different and visual'. Within previous TAM research, a number of researchers (Lucas & Spitler, 1999; Pai & Huang, 2011; Venkatesh & Bala, 2008) confirmed the importance of information quality for the perceived usefulness and the perceived ease of use. For instance, Shibly (2011) supported the strong

effect of information quality onto perceived ease of use and perceived usefulness within a research on electronic cheque clearing systems acceptance and also Wang and Lin (2012) supported both relationships within the mobile-service acceptance context. Due to the importance of information quality within previous research and for the participants within the present study, the research is making the following two propositions:

Proposition 1: Information quality will influence Perceived Usefulness.
Proposition 2: Information quality will influence Perceived Ease of Use.

Dimension Two – System Quality

With regards to the theme of system quality, participants identified a number of sub-themes including multi-language support, accuracy of system, navigation quality, quality of design and functions as well as the capability to segmentation according to groups or interests which is overall in accordance with previous research (Han et al., 2014a; Kounavis et al., 2012; Rodríguez-Fino et al., 2013; Yovcheva et al., 2012). Participants from each of the five focus groups raised the issue of language as the tested application only supported English. F1P3 for instance pointed out that 'if you're going to make the application international, then there would have to be different choices of languages in the application. So if the target audience in Dublin, might be…if it was China, then there would have to be Chinese language available, so in the current or particular place, making sure that the language is available'. This was agreed upon by F3P5, F3P7 and F4P9 who all confirmed that the application should be available in the most common languages in order to be widely accepted. Han et al. (2014a) furthermore supported the importance of multiple languages in order to enhance user experience.

The accuracy of the AR application was an additional sub-theme that was identified a number of times throughout the focus groups. F5P9 stated that 'you'd have to hold [the mobile] a certain way for it to pop up. If I was on my own, I wouldn't have thought that anything was there' and F5P8 contributed 'I would have thought that it doesn't work'. In addition, F2P8 pointed out that 'it was also not always in line. Like the buildings and monuments were a bit off side'. The importance of accuracy, especially in terms of GPS location was further supported by Olsson et al. (2012). In addition, navigation quality was considered immensely important by half of the focus group participants. The possibility to get directions to unknown places and attractions was considered a key advantage of the AR application. F5P1 pointed out that 'it's good if you didn't know where something was, like I wouldn't know that was the Spire, but if you hold it up and it gives you information on it. That's probably what I would use it the most, when I didn't know what something was and I wanted more information on it'. This strength of AR was furthermore supported by F2P2 stating that 'if you hold up your phone and it would show you places that you didn't know were there and you could try something new if you're not from the area. It could tell you where to go and give you directions so you don't get lost in a big city on your own'. In addition, the quality of the design and functions emerged as a sub-theme and has been confirmed by Han et al. (2014b). The possibility to save information on the device for instance was demanded by a number of participants (F1P4; F2P3; F2P7; F2P8). F2P3 stated that 'I think if we pull the information, it would be nice to have a copy of it. Let's say if you leave the museum, that you have at least a memory of it, or saved on your mobile phone or something. Because you know you might just be able to read it in the museum, but what if you would like to read it again at home. You know just to have the same information that popped out'.

A number of participants from focus group 2 (F2P3; F2P7; F2P8; F2P9) and focus group 3 (F3P2; F3P5; F3P8; F3P9) furthermore pointed out the importance of segmentation and tailoring the application context to the preferences of different target groups. F2P8 suggested that it would be a good idea to have different versions of the application 'to be adapted to the age group'. This was also supported by F3P2 pointing out that 'you could put different age groups in… and it tells you what to do' and also F3P8 revealed that the application should filter information based on a set profile. Also within previous TAM research, system quality was often identified to influence the perceived usefulness and perceived ease of use of new technologies. For instance, Lin (2010) supported the strong effect of system quality on perceived usefulness, while Pai and Huang (2011) confirmed the effect of system quality on perceived ease of use. McFarland and Hamilton (2006) supported both paths, from system quality towards perceived ease of use as well as perceived usefulness. Due to the importance of information quality within previous research and for the participants within the present study, the research is making the following two propositions:

Proposition 3: System quality will influence Perceived Usefulness.
Proposition 4: System quality will influence Perceived Ease of Use.

Dimension Three – Costs of Use

According to Kim, Chan and Guota (2007), within technology acceptance research, there are two types of costs, monetary and non-monetary. Participants within the five focus groups also identified these two types of factors in regards to AR acceptance. On the one hand, they suggested that the cost of the application (monetary) influences their overall acceptance. On the other hand, they pointed out that the cost comfort, missing out on information and disturbance are non-monetary costs that affect the overall acceptance. This is in line with a previous study on mobile internet acceptance by Kim et al. (2007) which identified that the perceived fee influences the perceived value and consequently the intention to use mobile internet.

The cost of the application has been extremely important throughout all focus groups. For instance, F3P1 argued that 'I'd pay for this if it was worldwide. I wouldn't pay for it, if it was just for Dublin or Manchester'. F1P6 furthermore pointed out that 'If I was going to a city I didn't know I'd probably pay for it' and F1P3 added that 'there are a lot of people who have iPhones or smartphones and they download a lot of games and applications and they pay for it as well'. Overall, participants acknowledged that they would be willing to pay if the application enhances their experience. In addition, Kim et al. (2007) suggested that there are also non-monetary costs that influence user acceptance which is in accordance with the findings from the focus groups. F1P4 and F1P8 identified that the cost of comfort has to be taken into account after raising that 'I think you'll get tired of holding your phone when you're reading on the walls in the museum' (F1P8). F1P8 furthermore acknowledged that using AR applications might result in a missing out of real-life experience as discovery is an importance element of the tourism experience: 'I wouldn't use it unless I get lost because I like exploring and walking around without knowing which way to go'. Finally, the cost of disturbance was identified by five participants (F2P1; F2P2; F2P7; F4P5; F5P9) and also Kim et al. (2007) acknowledged 'annoyance' as a key factor of cost of use within TAM research. F2P2 for example raised her concern by acknowledging that 'some people might quite find it a patronising device, like telling you where to go, what to do, you are holding it up and you feel kind of… very touristy'. Also F2P1 agreed that 'if you're on a day out and use it you

want to enjoy the day out and the people during the day' and F2P2 furthermore added that 'sometimes you just want to work things out for yourself…that's part of the fun of exploring'. Within their theoretical AR acceptance model, Leue et al. (2014) supported the importance of costs of use for tourists' acceptance of these new applications and therefore proposed that costs of use influences perceived ease of use and perceived usefulness. Due to the importance of costs of use within previous research and within the focus groups, the research is proposing that:

Proposition 5: Costs of Use will influence Perceived Usefulness.
Proposition 6: Costs of Use will influence Perceived Ease of Use.

Dimension Four – Recommendations

A number of participants suggested that they expect an applications to show ratings and recommendations based on the reviews from previous users (F2P6; F2P1; F2P2; F2P7; F5P4; F5P9) as well as based on own preferences according to previous application usage behaviour (F5P4; F5P5). F2P6 identified that 'if I want to eat something I want to know if it is good' and F2P1, F2P2 as well as F2P7 agreed with this. In addition, F2P2 stated 'so like if it came up in the Café and you're like, 'Oh I don't know' and you click on it, and there is lots of ratings, and they're like five star you'd want to go there. You'd be more inclined to give it a try'. Also F5P9 agreed that recommendations from previous visitors who have already experienced certain attractions, events, restaurants or hotels would increase the overall acceptance of the AR application and F5P4 furthermore strengthened the importance of recommendations. In addition, F5P4 and F5P5 suggested that an AR application should be built around ones' own preferences and that recommendations should be made while travelling according to these preferences. F5P4 suggested that 'maybe you could put your preferences before, like if you are near a location that you liked it would give you notifications and stuff like that'. The importance of word-of-mouth (WOM) was well established within previous tourism research due to uncertainties involved within the booking behaviour (Ayeh et al., 2013). Also within the AR tourism background, Han et al. (2014a) and Yovcheva et al. (2012) supported the importance of recommendations and WOM. Nevertheless, TAM research implementing recommendations and WOM as an external dimension that influences perceived usefulness and perceived ease of use is scarce. However, participants within the present study acknowledged the importance of recommendations within the AR context and therefore, the following two propositions are made:

Proposition 7: Recommendations will influence Perceived Usefulness.
Proposition 8: Recommendations will influence Perceived Ease of Use.

Dimension Five – Innovativeness

Two sub-themes that related to the dimension of personal innovativeness emerged throughout the focus groups. On the one hand, a number of participants (F1P3; F1P4; F3P5; F3P6; F4P4; F5P1; F5P2; F5P5) confirmed that the tested AR application created a WOW feeling due to its novelty aspect. The majority of participants used such an application for the first time thus, considered it very innovative. Furthermore, F3P5 concluded that 'I think it is really clever'. A number of TAM researchers supported the importance of personal innovativeness (Choi et al., 2011; Gao et al., 2012; Lee et al., 2006). Choi et al. (2011) and Lee et al. (2006) integrated personal innovativeness into their TAM research and supported

the path of the external dimension towards perceived ease of use and perceived usefulness and therefore, the following two propositions are made:

Proposition 9: Personal Innovativeness will positively influence Perceived Usefulness.
Proposition 10: Personal Innovativeness will positively influence Perceived Ease of Use.

Dimension Six – Risk

Risk has been recognised as an important indicator of technology acceptance, especially within the e-commerce environment and consumers' risk associated with online transactions (Stern et al., 2008). Within the tourism AR context, the focus group participants however identified another form of risk in regards to the risk of having the phone stolen while using it for exploring destinations and attractions (F2P7; F4P4; F4P5; F4P8; F5P4). F5P4 stated 'isn't it also like a safety thing, when you walk with a smartphone on the street, someone could obviously muck you'. F4P5 furthermore argued that 'someone could just grab it while you're holding it up to the Spire' and F4P4 agreed that 'it would feel like someone would nick the phone while you use it'. The nature of using AR in a destination requires tourists to hold mobile phones to scan objects to bring information to life. In addition, AR applications are immersive and could lead tourists to forget about their immediate surroundings (Lee et al., 2015). Therefore, the risk of having the mobile stolen can be higher than with normal mobile usage as the mobile phone is part of the tourism experience for a longer period (Pearce, 2011). Another form of risk was identified by F2P3. Recent revelations have shown that most applications on smartphones put privacy and security at risk (Bradley, 2013). Bradley (2013, p. 1) pointed out that '97 percent of the apps contained some sort of privacy issue… HP also found that 86 percent of the apps lack basic security defences, and 75 percent fail to properly encrypt data'. This concern was shared by one participant stating that a concern for an AR tourism application would be 'if it asks you too many personal details… I think most people are afraid that it could be shared with certain parties' (F2P3). A number of TAM researchers integrated trust into their acceptance researches (Choi et al., 2011; Herrero Crespo & Rodriguez Del Bosque Rodriguez, 2008; Stern et al., 2008). Stern et al. (2008) identified the effect of perceived risk onto perceived ease of use and Choi et al. (2011) acknowledged that risk influences both, perceived usefulness and perceived ease of use. Therefore, the present study makes the following two propositions:

Proposition 11: Risk will influence Perceived Usefulness.
Proposition 12: Risk will influence Perceived Ease of Use.

Dimension Seven – Facilitating Conditions

As a last theme, facilitating conditions emerged throughout the focus groups. The participants identified a number of issues with regard to hardware that might affect AR acceptance. F1P2 pointed out that 'if you don't have a device, then you're not going to be able to use it [and the same] if it runs out of battery'. The problem of battery durability was also supported by F5P9 pointing out that 'when you're using Google Maps, it just drains your battery'. F2P8 suggested that the hardware size plays another role for the acceptance stating that 'some are large and it's easier, some are small [and] if it's small you can barely use it'. In addition, storage was considered an issue by F3P8 pointing out that 'there might be no room for the app'. In this case it has to be considered whether the application content should be available offline thus, downloaded onto the mobile devices or cloud-based which saves storage and provides a bigger range of information (Han et al., 2014b). Also a large number

of previous research implemented facilitating conditions into their TAM (Lu et al., 2003; Maldonado et al., 2010; Pan and Jordan-Marsh, 2010; Teo, 2010). Teo (2010) supported the path of facilitating conditions towards perceived usefulness and Lu et al. (2003) argued that facilitating conditions influences both, the perceived ease of use and perceived usefulness. Based on the focus group results and previous literature, the following two propositions are made:

Proposition 13: Facilitating Conditions will influence Perceived Usefulness.
Proposition 14: Facilitating Conditions will influence Perceived Ease of Use.

Perceptions

Dimensions Eight and Nine – Perceived Usefulness and Perceived Ease of Use

Perceived usefulness and perceived ease of use have been common antecedents of users acceptance of new technologies for a number of years. In addition, Sanchez and Hueros (2010) confirmed the effect of perceived ease of use onto perceives usefulness and the effects of the aforementioned onto users' attitude. Also within the tourism AR context, F3P1 identified that it is easier and more convenient to use applications to do the research on attractions and destinations while travelling. In addition, she mentioned that it is more useful than carrying books around while travelling. Also within focus group 1, F1P6 identified 'everyone has smartphones nowadays as well as everyone uses apps and knows how to use it so I think it's quite handy'. Focusing on the perceived ease of use, F3P5 stated that the application was 'easy to use, which is good' for the overall experience and all participants within the focus group agreed with this point. Also within focus group one F1P9 acknowledged that the application is easy to access and F1P4 added that 'it was quick as well [and] it was working quite fast… so that's a good point'. In addition, instructions were suggested to enhance the ease of use of the mobile application (F3P10). Furthermore, F3P10 suggested 'when you buy it, it should have a start page that explains how to use it' which was agreed upon by all other participants from the same focus group. In addition, F4P5 revealed that it has to be thoroughly explained how to use the application for a seamless experience which was confirmed by F4P2, F4P4 and F4P7. F1P4 raised another point relating to the costs of effort revealing that 'maybe people that are used to using maps and findings things out themselves and where to go to, like the tourism offices and stuff in the city centre to use some maps and stuff rather than going on their phone and trying to use the technology. It's less effort for them to talk to somebody face to face to find out about all the attractions that interest them'. This is in line with previous research that identified that TAM research should include effort costs (Leue et al., 2014). In addition, Toft et al. (2014, p 393) revealed that the dimension of perceived ease of use can be defined as "the degree to which use of that particular technology is believed to be easy and effortless", incorporating Davis et al. (1989) perception of perceived ease of use, which is supporting the importance of cost of effort in the TAM context. Based on the focus group results and previous literature, the following three propositions are made:

Proposition 15: Perceived Ease of Use will influence Perceived Usefulness.
Proposition 16: Perceived Ease of Use will influence Attitude.
Proposition 17: Perceived Usefulness will influence Attitude.

Attitude and Behavioural Intention

Dimensions Ten and Eleven – Attitude and Behavioural Intention

All participants in focus group 3 agreed that they liked the idea of using an AR application to experience Dublin. However, not all participants had a favourable attitude towards the application. F1P10 suggested that 'we should limit the use of it. You are actually in a new place and here to discover it'. She furthermore pointed out that tourists should experience new places through their own eyes instead of starring on their smartphones and therefore, she concluded 'I wouldn't use it very much'. A similar point was made in focus group 2, F2P7 stated 'I think it's not good to move around with your phone… you will be too focused and you don't know what's around you'. F2P3 furthermore argued that the whole idea behind tourism is to experience destinations and that using an application for this is 'a bit pointless'. On the contrary, F2P1 acknowledged 'I would use it all the time'. This shows the link between attitude and behavioural intention as tourists with a favourable attitude are more likely to use an application than those with an unfavourable attitude. Nevertheless, numerous participants agreed that they would use the application when travelling in the future (F3P1, F4P7; F5P8). F3P5 pointed out 'I would download the app' and F3P7 for instance stated 'I would use the app'. Based on the focus group results, the following proposition is made:

Proposition 18: Attitude will influence Behavioural Intention to use.

Please insert Table 2 about here

Discussion and Conclusion

The present study aimed to contribute to the gap in the AR acceptance literature by the identification of external dimensions. The analysis of the focus groups has revealed that there are seven external dimensions that influence young British female tourists' acceptance of mobile AR applications. The identification of external dimensions of AR acceptance is particularly important as this research area is still new and received little attention by previous scholars. Therefore, Leue et al. (2014) called for a qualitative investigation of potential external dimensions within the AR acceptance context. Figure 2 presents the AR acceptance model, based on the original TAM by Davis et al. (1989), including external dimensions that are explicitly applicable to the AR urban heritage tourism context. According to the proposed model, information quality, system quality, costs of use, recommendations, personal innovativeness, risk and facilitating conditions influence the perceived ease of use and perceived usefulness of using AR applications. In addition, the AR acceptance model, similar to the original TAM, suggests that perceived ease of use has a positive effect onto perceived usefulness as well as the attitude towards using. Furthermore, it is suggested perceived usefulness has a positive effect towards attitude which in turn affects the intention to use and consequently the actual usage behaviour.

Please insert Figure 2 about here

The present study presents a mobile AR acceptance model, an area that only received limited attention within information system research. The proposed model suggests that young British female tourists' mobile AR acceptance may be dependent on seven external dimensions such as information and system quality, costs of use, recommendations and personal innovativeness, risk as well as facilitating conditions. The present study contributes to the gap in the literature acknowledged by Leue et al. (2014). In addition, it provides context-specific external variables of technology acceptance as demanded by Ayeh et al.

(2013). The focus group outcomes suggest that information and system quality are considered important in terms of mobile AR acceptance within the tourism context. However, also the costs of use in terms of receiving free Wi-Fi or having to pay for the Internet as well as the application was perceived as an acceptance factor. Especially, difficulties with roaming fees were acknowledged by a number of participants. Nevertheless, costs of use were also related to the missing out on the real tourism experience and the annoyance factor of always being engaged with a smartphone. Furthermore, recommendations, personal innovativeness and risk as well as facilitating conditions emerged as important factors of mobile AR acceptance within the tourism context. However, taking into account Venkatesh et al. (2000) it is important to remember that the present study focused on the young British female tourist market and that further research is need to compare the proposed model with the male market as well as an older target market or different nationalities to account for a full spectrum of acceptance factors. Dublin AT is currently in an exploratory and developing stage and therefore, findings of this study will contribute to the final application development.

Theoretical implications

There are a large number of researches that focused on using the TAM to explain users' acceptance behaviours. The TAM study by Davis (1986) originated from organisations' IS acceptance, thus researchers questioned the reliability of external dimensions within the voluntary consumer environment in later TAM studies (Baron et al., 2006). In order to overcome this limitation, the present study aimed to propose a mobile AR acceptance model based on focus groups. This study differs from earlier conceptual papers of TAM (Leue et al., 2014; Wu, 2009) because it uses a qualitative approach to identify relevant external dimensions that influence young British female tourists' mobile AR acceptance. The majority of earlier TAM research identified external dimensions from secondary literature (Ayeh et al., 2013a; Lee & Lehto, 2013; Leue et al., 2014; Wu, 2009). This research provided a guidance on the external dimensions that future TAM research should identify context-specific factors suggested by Ayeh et al. (2013a) and Leue et al. (2014). Furthermore, Baron et al. (2006) acknowledged that qualitative methods extend the applicability of TAM studies. Therefore, the current research, proposing seven external dimensions, makes a valid contribution to the body of knowledge which will provide guidance for further research. However, the focus of this study was on the young British female tourist market and unfortunately it was not possible to collect data from young British male tourists for comparison and therefore future research should address this.

Managerial implications

Tourism organisations and destinations can benefit from the findings of this study as it displays first findings of young British female users' perceptions regarding mobile AR application within the urban heritage tourism context. Seven factors that influence mobile AR acceptance were identified and practitioners can base their future AR attempts on these findings by particularly focusing on the issues raised by young British female tourists. It was clearly identified that information and system quality as well as costs of use were considered key factors by users. In addition, considering the novelty factor of AR applications for the enhancement of visitors' tourism experience, these findings provide practitioners with basic ideas as to how mobile AR applications should be designed in order to be accepted by young British female tourists. In addition, app developers can benefits from the findings as it provides guidance on important factors for AR application design. In addition, previous literature identified that urban heritage destinations often struggle with the use of space (Jung

& Han, 2014; Kalay et al., 2007). This study provides urban cultural heritage professionals with a theoretical framework and guidance as to how future applications should be designed and implemented in order to be accepted by young British female tourists. This provides opportunities to enhance the overall experience and at the same time preserve historic architecture or art. In the future, AR will help the preservation of historic and enlisted sites by eliminating the requirement for numerous signs.

Limitations and Future Research

There are a number of limitations within this present study. The existence of gender differences was supported by numerous researchers (e.g. Kimbrough et al., 2013; Weiser, 2011). For instance, Kimbrough et al. (2013) acknowledged that females are more concerned with interactivity than males. On the contrary, Weiser (2001) identified that men are more likely to focus on information gathering. Therefore, future research should investigate gender differences in AR acceptance by also taking males as a sample. The present study used students from a field trip as sample and due to the characteristics of the group of students, only females participated and therefore this study is only representable for the young female British travellers market. Furthermore, students are generally considered as a limited sample as the findings cannot be generalised to an entire population. Nevertheless, the aim of this study was to investigate acceptance factors for the young female British travellers market and therefore, the sample of British students is considered appropriate. As with all qualitative analysis techniques, a further limitation is a potential bias in analysing qualitative data. However, the use of a predefined codebook reduced the risk of a researcher biased analysis. According to DeVellis (2003) a proper measurement scale development is crucial in order to receive reliable and valid outcomes. Therefore, future research can use the identified themes and sub-themes to develop measurement items and test their validity within mobile AR acceptance research. The proposed model was only qualitatively tested by the young female British travellers market. Future research is advised to quantitatively test the model through structural equation modelling to validate the proposed model. Furthermore, the model could be tested and validated within different research contexts for instance, a comparative study among different cultural contexts. In addition, in light of the advancements in wearable technology, future research is recommended to focus on wearable AR acceptance using these new technologies.

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Table 1. Focus group questions

#	Questions
1	What's your overall or general opinion about the Augmented Reality (AR) application?
2	What did you like in particular about the AR application you have experienced?
3	Which areas of the AR application would you improve?
4	Which features do you consider beneficial/useful for the AR application you have experienced?
5	a) What kind of content interests you in particular? b) How should it be included in the AR application?
6	Could you think of a reason not to use the AR application?
7	What might be reasons for other people (in your friends/family circle) not to use the AR application?
8	Would you use the application in the future and why?

Table 2. A Summary of Key Findings

| Themes	Sub-themes	Key findings
External dimensions	Information quality	Importance of gathering of information
		Timeliness of information
		Relevance of information
		Attractiveness of information
	System quality	Multi-language support, Language quality
		Accuracy of system
		Navigation quality
		Design quality
		Personalization according to interests
	Costs of Use	Cost of comfort
		Costs of internet
		Costs of missing out on information
		Cost of application
		Annoyance, tourists might just want to explore by themselves
	Recommendations	Word of mouth, star rating system from other users
		Preference, recommendations given based on previous behaviour
	Personal innovativeness	Excitement, WOW feeling
		Cleverness
	Risk	Privacy concerns
		Risk of having phone stolen
	Facilitating conditions	Availability of hardware
		Battery life, battery should not be drained
Perceptions	Perceive usefulness	Alternative to traditional visit
		Convenience of gathering information
	Perceived ease of use	Instructions needed to facilitate handling
		Costs of effort
Attitude	Attitude	Favourable
		Unfavourable
Behavioral intention	Intention to use	Use application
		Download application

Fig. 1a. Test of GPS-based AR

Fig. 1b. Test of marker-based AR
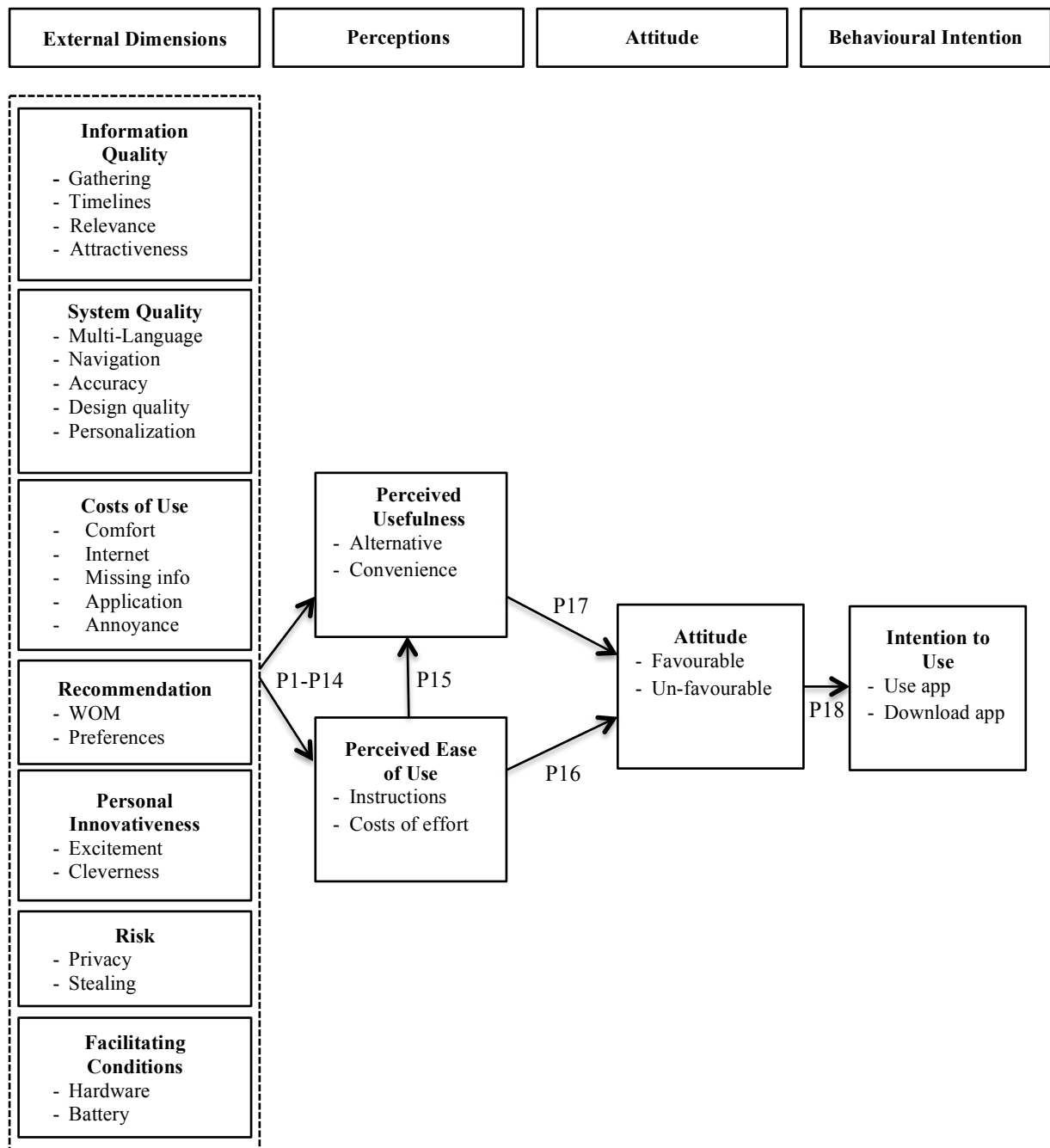
Fig. 2. Augmented Reality Acceptance Model