New Realities: A Systematic Literature Review on Virtual Reality and Augmented Reality in Tourism Research

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Abstract
Despite the growing interest and discussions on Virtual Reality (VR) and Augmented Reality (AR) in tourism, we do not yet know systematically, the knowledge that has been built from academic papers on VR and AR in tourism; if and how VR and AR research intersect, the methodologies used to research VR and AR in tourism, and the emerging contexts in which VR and AR have surfaced in tourism research. By conducting a systematic literature review on VR/AR research in tourism, this work seeks to answer five main research questions: (1) Which tourism sectors and contexts have VR and AR research emerged in?; (2) Which forms of VR and AR have garnered the most attention in tourism research?; (3 & 4) What methodologies/theories are being utilised to research VR and AR in tourism?; and (5) What are the research gaps in VR and AR tourism research? From a synthesis of 46 manuscripts, marketing and tourism education emerged as the most common contexts. However, issues with heterogeneity appeared in terminology usage alongside a lack of theory-based research in VR and AR. Also, gaps were identified where challenges identified revolved around awareness of the technology, usability, and time commitment.

Keywords: Virtual Reality, Augmented Reality, tourism development, Systematic Quantitative Literature Review, methodology1, virtual tourism

1.0 Introduction

'Every 10 or 15 years, there's a new major computing platform… And now we're starting to get ready for the platforms of tomorrow. By far the most exciting future platform is around vision, or modifying what you see to create augmented and immersive experiences. When you put on their goggles, you enter a completely immersive computer-generated environment, like a game, or a movie scene or a place faraway. Today, social networks are about sharing moments. And tomorrow, they'll be about sharing experiences.' The above statements were made by Facebook CEO Mark Zuckerberg in 2014 shortly after acquiring Virtual Reality company Oculus for USD 2 billion (Thomson Reuters, 2014). As at the end of 2016, Oculus (https://www.oculus.com/), alongside Sony (https://www.playstation.com), Samsung (http://www.samsung.com/global/galaxy/gear-vr/), Google (https://vr.google.com/), HTC (https://www.vive.com), and Microsoft (https://www.microsoft.com/hololens) have unveiled Virtual Reality (VR) and Augmented Reality (AR) products to the mass market. With the exception of Microsoft's Hololens, the six corporations have their products on shelves, indicating that the tools for mainstream VR and AR consumption have moved out of the early adopter or developer phase, and are now ready for mainstream consumer usage.

Early conceptual papers on VR and AR have contemplated the potential applications for the technologies, positing that the depth and extension of sensory participation would alter and expand the avenues of information dissemination (Cranford, 1996; Zhai, 1998). In tourism, where informative communication of intangible products has always been vital (Huang, Backman, Backman, & Chang, 2016), the impending arrivals of VR and AR ranged from being hailed as a new horizon (Hobson & Williams, 1995), to virtual threats (Cheong, 1995). However, these were merely projections and theoretical implications of the technology within the tourism sector, with empirical data of tourists' experiences remaining relatively unexplored (Tavakoli & Mura, 2015). Far more effort has been spent on predictions of revolutionary futures than on exploring the ways which it is being incorporated into people's daily lives (Hine, 2000). This could perhaps be explained by the fact that VR and AR technology has only recently been available to the mainstream consumer. Whilst scholars have called for more studies in AR and VR (Jung, Chung, & Leue, 2015; Mura, Tavakoli, & Pahlevan Sharif, 2016; Pantano & Servidio, 2011), the status of AR/VR studies in tourism have not yet been mapped. In a nascent field such as this, an investigation of prior research is important to reveal the current state of research and offer guidance to researchers seeking to enter the discussion (Höffler & Leutner, 2007; Karatas, 2008). More specifically, mapping the trajectory of research to date will help researchers identify trends and determine the subjects which are of continuing importance (Davies, Howell, & Petrie, 2010). Therefore, this paper aims to review existing literature on VR and AR in tourism. Specifically, this study systematically investigates and synthesizes the extant literature concerning VR and AR in tourism, with an aim to outline what has been discussed thus far and identify areas for future research.

By mapping what is known, this review will lay the groundwork, providing a timely insight into the current state of research on virtual and augmented reality in tourism. Through a systematic quantitative literature review of articles published in tourism and hospitality journals, this is achieved through meeting the following objectives: (1) to identify tourism sectors and contexts which VR and AR research have emerged in; (2) to identify the forms of VR and AR which have garnered the most attention in tourism research; (3) to identify methodologies being utilised to research VR and AR in tourism; (4) to identify the theories being utilised in VR and AR research in tourism; (5) to identify the research gaps in VR and AR tourism research. From the review's findings, a comprehensive view of the emerging advantages and challenges of VR and AR adaptation in

tourism is drawn. This in turn provides opportunities, directions, and avenues for the coming years of research in this increasingly important subfield of tourism studies.

2.0 Literature Review

2.1 Virtual Reality

The commonly accepted definition for VR is the use of computer-generated 3D environment, that the user can navigate and interact with, resulting in real-time simulation of one or more of the user's five senses (Burdea & Coiffet, 2003; Gutierrez, Vexo, & Thalmann, 2008; Guttentag, 2010). More specifically, the three key elements that characterise VR are: (1) *Visualisation*, where the user has the ability to look around, usually with the use of a head-mounted display; (2) *Immersion*, suspension of belief and physical representation of objects; (3) *Interactivity,* degree of control over the experience, usually achieved with sensors and an input device like joysticks or keyboards (Cruz-Neira, Sandin, DeFanti, Kenyon, & Hart, 1992; Williams & Hobson, 1995). Two terms commonly found within VR research are Virtual Environments and Virtual Worlds. Guttentag (2010) described the experience of VR as the user being immersed in a virtual environment. The term is also used by Singh and Lee (2009) in their study on using virtual environments in tourism education. Even though the essence of their study discusses concepts that characterise VR, the term virtual reality is never used, with the authors opting to use virtual environment. As it is not a technical term, the definition of virtual environment in research ranges vastly from being described as simple as e-learning (Bray, 2002), to arguably the most immersive form of VR- virtual worlds (Singh & Lee, 2009).

Virtual worlds are described as persistent virtual environments, open 24/7, and enabling people represented by avatars (a personal representation in 3-D form) to create, play, and interact in real time. (Penfold, 2009, p. 140). Currently, one of the most active virtual world platforms is Second Life, an internet-based virtual world where avatars socialize, network and create their own virtual spaces (Huang et al., 2016). Founded in 2003, Second Life boasts 36 million residents with more than 1 million active users monthly (Linden Lab, 2013). In 10 years, transactions within the virtual world economy amounted to USD 3.2 billion (Linden Lab, 2013). The rise in popularity of virtual worlds has not gone unnoticed in the tourism industry with Sweden, Maldives, Estonia, Kazakhstan, Serbia and Italy all having virtual embassies alongside hospitality organisations like Starwood, Hyatt, STA, and Crowne Plaza in the Second Life virtual world (Huang et al., 2016; Wyld, 2010). Actual tourism sites range from re-creations of Paris' Eiffel Tower and *Arc de triomphe de l'E´toile* to Kenya's Maasai Mara villages which avatars can examine, walk around and interact with (Hsu, 2012; Huang et al., 2016). Much like reality, the social aspect is prominent, where avatars can travel to these attractions in groups and interact with other avatars present at the site. Even tourism education is marketed in Second Life, with The Hong Kong Polytechnic University's School of Hotel and Tourism Management creating a virtual campus on the platform (Penfold, 2009). This is interesting because acquiring land to set up things like embassies and virtual campuses in Second Life requires real money. Instead of being an unlimited sandbox, Linden Lab describes buying land as akin to renting storage space on their servers, with more land costing more money. This means that these embassies, universities, virtual hotels and other tourism entities view time and financial outlays in Second Life as a worthwhile investment. This signals the growing importance of virtual worlds in the tourism industry and yet, academic research remains scant (Mura et al., 2016).

2.1.2 Augmented Reality

AR can generally be defined as the enhancement of a real-world environment using layers of computer-generated images through a device (Guttentag, 2010; Jung et al., 2015). Guttentag (2010) posited that AR is a type of VR. This echoes Milgram, Takemura, Utsumi, and Kishino (1994)'s view that AR and VR are related and it is valid to consider the two concepts together. In the same paper on mixed-realities, Milgram et al. (1994) argue that AR and VR should be viewed as lying on different ends of the Reality-Virtuality continuum (Figure 1) where one end consists of solely real world objects and the other end consisting of solely synthetic or computer-generated objects.

[Figure 1 near here]

Figure 1. Simplified representation of a RV Continuum (Milgram et al., 1994, p. 283)

The difference for the user is the level of immersion. With AR, a large majority of what the user sees is still the real world whereas with VR, the user is fully immersed into a virtual environment. Recent advancements in mobile computing have led to the development and increase of AR applications in tourism where the geolocation capabilities of mobile devices translate well into providing users with context-sensitive information on their immediate surroundings (Yovcheva, Buhalis, & Gatzidis, 2012). An example is mTrip (https://www.mtrip.com/), a travel-focused smartphone application that integrates AR into their city guides. Using the smartphone camera viewfinder, information such as directions or ratings of attractions is overlaid on the display and changes based on what the phone is pointed towards. However, despite the touted benefits of the technology to the tourism industry, research and literature on AR in the tourism context remains limited (tom Dieck, Jung, & Han, 2016).

2.2 Research in VR and AR

Cranford (1996) described VR as 'bringing down the final set of walls, having the world brought into our homes, whilst at the same time, from our homes, entering the world' (p. 90). He stressed the importance of understanding the utilisation of VR, as the depth of sensory participation translated well into potential applications in industries such as design, architecture, education, entertainment, health and science.

In health research for example, Cho et al. (2008) adapted VR to simulate social pressure in high-risk situations, inducing alcohol-craving in participants. The ability to simulate the experience in a controlled environment allowed participants to recognise signs of alcohol-craving and treat it. McLay et al. (2011) found that using VR-based therapy resulted in clinically significant improvement in treatment of post-traumatic stress disorder for military personnel who served in Iraq or Afghanistan, when compared to 'treatment as usual'. This was attributed to the interactivity and controlled environments that the simulations allowed. In the retailing and consumer services space, AR's geolocation and personalisation capabilities allow the delivery of more precise and tailor-made marketing messages to consumers, which leads to more positive attitude, higher trust, and consequently higher intention to purchase (Javornik, 2016). Similarly, Suh and Lee (2005) found that particularly for products requiring vision and hearing for inspection, consumer learning improved when using a VR interface. In education, Kurilovas (2016)'s systematic literature review on VR and AR found that VR/AR-based systems were more effective in improving student motivation and satisfaction than traditional ones, especially for situated, inquiry-based, and self-regulated learning. However, the review found that the adapted applications still lacked finesse, with most studies putting too much emphasis on entertainment and generally being limited by simple visualisations. In another systematic literature review on AR in education research, Akçayır and Akçayır (2017) found some conflicting conclusions. For instance, usability or ease of use appeared as the biggest challenge

in some studies and the biggest advantage in others. However, the overall conclusion from the studies found that AR enhanced enjoyment, motivation and interaction of learners. Through the systematic literature review, they were able to suggest several avenues for future research such as a call for more studies specifically focused on addressing usability challenges not just for learners but educators as well. Identifying heterogeneity in reports on cognitive overload also broadens avenues to revisit that particular trait and the research conditions that could have resulted in the varied outcomes. The various different fields of research indicate the growing importance of recognising the advantages of VR and AR over traditional forms of media communication such as videos and images. However, the diverse nature in how VR/AR is being used as a tool also accentuates the need to understand and adapt the technology to each different industry. The systematic literature reviews on both VR and AR in the education sector allowed for a quick overview of the current state of research and where it is headed. The outcomes, contributions, and subsequent implications of these reviews highlight that a systematic review of VR/AR literature in tourism is long overdue.

2.3 VR and AR in Tourism

Hobson and Williams (1995) posited that travel itself is to a large extent a secondary reality, which the tourist escapes into temporarily. Tourists are happy to escape into known simulated experiences like Disneyland, totally absorbed into staged alternate realities (Cohen, 1979). It can be argued that the application of VR/AR into the tourism experiences merely pushes this alternate reality one step further (Williams & Hobson, 1995). Research has shown that VR's greatest strength is its ability to visualise spatial environments (Guttentag, 2010). This is especially crucial in tourism where products are intangible and are confidence goods which consumers are not able to test in advance. Putting on a VR headset and being able to compare different destinations could help consumers make informed decisions (Cheong, 1995). Wan, Tsaur, Chiu, and Chiou (2007) found that for theme parks, virtual experiences provided more effective advertising compared to brochures due to the richness and interactivity of the information. This is supported by studies that show the ultimate goal for web-based destination marketing is to provide travel information to tourists via a vicarious experience of the destination to persuade them to visit (Huang et al., 2016). VR can cater specifically to the vicarious experience by allowing the user to experience selected visual, audio, and most importantly, spatial aspects of the destination without actually being there. Therefore, there is a need for research on adaptation of these attributes for the optimal application of VR as a tourism tool.

Facets of VR and AR have already been adopted by the tourism industry. Destination BC (http://bcexplorer.com/) in British Columbia, Canada and Tourism Australia (http://www.australia.com/) have fully interactive VR experiences available on their websites. Supported by the local office of information and tourism, Zarzuela, Pernas, Calzón, Ortega, and Rodríguez (2013) recreated the city of Valladolid in Spain, allowing the user to roam the city and learn facts about it in a virtual experience. Mesároš et al. (2016) did an overview of AR applications currently available in tourism, focusing on AR experiences delivered through smartphones. They also developed the NosfeRAtu app, an AR game located in Slovakia's historical Orava Castle. In the cultural heritage sector, AR has seen some conflicted opinions. On one hand, studies have shown that AR enables a more dynamic and innovative way to provide users with enhanced information in museums (tom Dieck et al., 2016). Conversely, resistance to adopting the technology was seen in heritage site managers fearing it would dilute the objective authenticity of the sites (Dueholm & Smed, 2014). Nevertheless, it is clear that a multitude of tourism-focused utility for AR and VR have started to emerge. Gamification, tourism education, destination marketing, and cultural heritage are just some of the tourism sub-sectors which have utilised VR in different ways. Although research in understanding tourism innovations has been gaining momentum, there has been a recent call for

more substantive and theory-based research into user experience and consumer behaviour (Huang et al., 2016). Despite the growing interest and discussions on VR and AR in tourism, we do not yet know systematically, the knowledge that has been built from academic papers on VR and AR in tourism; if and how VR and AR research intersect, the methodologies used to research VR and AR in tourism, and the emerging contexts in which VR and AR have surfaced in tourism research. In light of these gaps, the main purpose of this paper is to conduct a systematic literature review on VR/AR research in tourism. By mapping what is known, this review has laid the groundwork, and identified gaps and opportunities for future research to build upon. Findings from the review contribute toward drawing a comprehensive view of the emerging advantages and challenges of VR and AR adaptation in tourism; unveiling opportunities, directions, and avenues for the coming years of research in this increasingly important subfield of tourism studies. The research questions for this review therefore are:

1. Which tourism sectors and contexts have VR and AR research emerged in?
2. Which forms of VR and AR have garnered the most attention in tourism research?
3. What methodologies are being utilised to research VR and AR in tourism?
4. What theories are being utilised to research VR and AR in tourism?
5. What are the research gaps in VR and AR tourism research?

3.0 Methodology

Given that the purpose of this study was to map the current state of research on VR and AR in tourism, the best suited method to address this aim is the systematic quantitative review. A systematic and quantitative approach is feasible in mapping the boundaries of what is known and thus sheds light on what is yet to be known (Pickering, Grignon, Steven, Guitart, & Byrne, 2015). The method is also particularly suited to assessing emerging trends within disciplines (Pickering & Byrne, 2013) and therefore deemed the most suitable method for the purposes of this paper. The type of review is systematic as the methods used to survey and select the papers are explicit and reproducible (Pickering & Byrne, 2013). Systematic quantitative reviews have been previously applied in the tourism context to examine topics such as tourism doctoral research (Weiler, Moyle, & McLennan, 2012), and risk and gender research (Yang, Khoo-Lattimore, & Arcodia, 2017). A similar bibliometric method was also utilised by Ruhanen, Weiler, Moyle, and McLennan (2015) in tracking trends and patterns in sustainable tourism research. Using a traditional narrative review is less rigid and some argue more comprehensive (Mays, Pope, & Popay, 2005). However, even though findings are discussed, they are rarely synthesized and mapped to demonstrate trends and patterns. Consequently, in the light of this paper's purpose, a traditional narrative review is inappropriate.

The review process follows closely that of Yang et al. (2017), who employed the method for their systematic quantitative literature review of risk and gender research in tourism. The five-step review protocol, adapted and streamlined for social sciences from Pickering and Byrne (2013)'s systematic quantitative literature process, consists of (1) determining review aims and formulating research questions; (2) Identifying search terms, databases, and literature selection criteria; (3) searching the databases for the literature and screening search outcomes against the criteria before refining exclusion and inclusion criteria; (4) appraising literature quality and relevance, structuring summary tables through extracting relevant information; (5) synthesizing and reporting findings.

Given this study's review aims, the search strings "augmented realit*" OR "virtual realit*" OR "virtual world*" OR "virtual environ*" were used in titles, keywords and abstracts to search for relevant literature firstly in the Scopus academic database, followed by four additional databases; EBSCO, Elsevier, Proquest, and Emerald. Scopus was identified as the most powerful of the seven databases identified by Yang et al. (2017) as its advanced search capabilities exceed those of other databases. As it functions as a search engine of other databases, it also produced the most results. For example, the same search string produced 40 results in Scopus, but only 38 in EBSCO, followed by 19 in Proquest, 10 in Elsevier, and three in Emerald. A filter was then used to limit results to only articles from journals with 'tourism' or 'hospitality' in the name. To safeguard the quality and effectiveness of the review, only original research articles published in English-language peer-reviewed journals were considered. The search was not time-bound due to the emerging nature of VR/AR in tourism research. This means that we did not limit the search to any particular time period or any specific number, which allowed for a more comprehensive mapping of VR/AR in tourism research. Results of the literature search are outlined in Figure 2, in accordance to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, Altman, & Group, 2009) guidelines, with minor adjustments to fit the study purpose.

[Figure 2 near here]

Figure 2. Summary of systematic quantitative review research process.
Source: Yang et al. (2017)

The initial search using Scopus produced 40 articles. A combination of the four supplementary databases yielded 70 additional results. Removing the duplicates left 53 articles for analysis. Two of these articles were removed as they were not accessible. The 51 remaining articles were analysed in full. After screening against the literature selection criteria, a further five were then excluded from the final synthesis. Two non-journal publications (conference reports) were eliminated. Three other studies were excluded as VR/AR was not the research focus of the study. These studies vaguely listed virtual environments or virtual worlds amongst the potential possibilities for solving current issues such as sustainability, without actually exploring or explaining what VR/AR is. Thus, the final number of articles included in the synthesis was 46. Information from the studies was coded in Microsoft Excel. Findings were reviewed and examined iteratively by both researchers, and re-coded where necessary.

4.0 Findings and Discussion

Table 1 summarises the 46 peer-reviewed research articles on Virtual Reality and Augmented Reality which were published in 24 tourism journals (Table 2). *Tourism Management* published the most articles (19.57%) followed by *Journal of Hospitality and Tourism Technology* (10.87%).

[Table 1 near here]

[Table 2 near here]

4.1 Types of VR and AR in Tourism Research

One aim of this paper was to map the emerging trends of how VR/AR is being studied. Table 3 summarizes the forms of VR/AR studied in tourism.

[Table 3 near here]

Virtual worlds were the most common focus (39%). All studies of virtual worlds were based on the Second Life virtual world. The most common focus was studying the destination marketing potential of Second Life (Guillet & Penfold, 2013; Huang et al., 2016; Huang, Backman, & Backman, 2012; Huang, Backman, Backman, & Moore, 2013; Huang, Backman, McGuire, Backman, & Chang, 2013; D. Kim, Jang, & Adler, 2015; K. Kim & Oh, 2009; Mascho & Singh, 2013). The studies explored how the increased interactivity and presence of Second Life affected awareness of tourism sites and trip-planning. In general, they found that participants developed positive feelings and increased awareness toward the destinations. However, a common concern to using Second Life as a marketing platform was the lack of awareness of virtual worlds amongst the general population. Almost all the researchers identified general technical difficulties as barriers for their participants. A further six studies explored integrating Second Life as part of tourism courses in universities (Deale, 2013; Hsu, 2012; Huang, Backman, & Backman, 2010; Huang, Backman, Chang, Backman, & McGuire, 2013; Penfold, 2009; Singh & Lee, 2009). The studies found that students showed increased motivation, with many participants describing the experiences as more interesting and interactive. Similar to the studies on destination marketing, technical difficulties and uneasiness-of-use were a common concern, specifically for the educators. Zelenskaya and Singh (2011) explored the use of job fairs in Second Life. While all interviewed organisations agreed that there was a big future in the platform, they felt that usage from the general population was still lacking. Ultimately, only one hospitality organisation had used Second Life for recruitment purposes.

Given that the boundaries of the terminology Augmented Reality is well-defined, we could identify undoubtedly eight studies for this category. The types of VR were a lot more heterogeneous in the terminology used. 11 studies focused on virtual environments. However, as stated earlier in the paper, because the term virtual environment is not particularly technical, the studies using the term ranged from virtual tutoring (Bray, 2002), to virtual meetings (Gustafson, 2012), e-learning platforms (Haven & Botterill, 2003), and screen golf (Han, Hwang, & Woods, 2014). Virtual Reality (13%) studies were those that did not particularly focus on any one type of VR. These were conceptual papers which discussed the future of VR in tourism in general. Virtual communities appeared as a category even though it was not part of the search terms in three studies (Breukel & Go, 2009; Kavoura & Bitsani, 2013; Luo & Zhang, 2016). In the three studies, researchers used terms like virtual reality and virtual environment but never explicitly state their definitions of the terms and focus more on destination marketing in virtual communities akin to social media networks.

4.2 VR and AR Research in Tourism Sub-sectors

The purpose of this paper was to cast light onto the tourism sectors in which VR/AR research has emerged. This is important in assessing emerging trends within disciplines, mapping what is known thus far (Pickering & Byrne, 2013). Table 4 provides an overview of the contexts in which VR and AR studies were done. The following sections detail the findings of the studies and highlight research gaps in each of the categories except for the seven conceptual papers. This is because they have been discussed in the literature review section.

[Table 4 near here]

4.2.1 VR and AR Research in Marketing

The most common context in which VR and AR was researched was as a marketing tool (28.26%). These studies explored VR and AR as a tool which could strengthen awareness, branding, and destination marketing, with the goal of increasing visitor numbers to the locations. Regardless of the type of VR or AR, the studies focused on the themes of visualisation and enhanced information dissemination. From the literature, Cheong (1995) posited that putting on a VR headset and being able to compare different destinations would help immensely in consumers making informed decisions. The view is echoed by Berger et al. (2007) and then Guttentag (2010), finding the ability to visualise spatial environments to provide rich information to tourists in the planning stage as the technology's biggest strength. This is especially crucial in tourism where products are intangible which consumers are not able to test in advance. Several studies found that the increased engagement and involvement participants felt when interacting with VR led to increased positive feelings toward the destination (Huang et al., 2016; Huang et al., 2012; J. Kim & Hardin, 2010). In fact, all participants in Pantano and Servidio (2011)'s study expressed a desire to travel to the real tourism site to compare it to the one reconstructed in VR. However, these were guided demonstrations where the VR experiences were specifically set up and presented to participants. Mascho and Singh (2013)'s study highlighted that there is still a lack of general awareness of the various VR and AR platforms and also that when unaided, participants often struggled with their lack of technological capabilities. This was common across all areas as a problem that VR/AR has yet to overcome. Apart from the barrier of cost, the general consensus was that usability remained a challenge to mainstream market penetration. Therefore, there is a need for research on adaptation of the technology for the optimal application of VR as a tourism marketing tool. Technological advancement, and in particular the internet, has revolutionised the way destination marketing organisations (DMOs) provide information, communicate, and interact with both consumers and providers (Burgess, Parish, & Alcock, 2011). At the same time, one of the biggest challenges DMOs face is understanding and searching for the latest technologies that will revolutionise interaction with information (Gretzel, Fesenmaier, Formica, & O'Leary, 2006). With destination marketers already investing into VR as the next marketing platform, research on VR as a marketing tool is likely to have practical implications for the tourism industry.

4.2.2 VR and AR Research in Tourism Education

Given that AR and VR is already widely used in educational settings (Akçayır & Akçayır, 2017), the second most common category of VR/AR studies in tourism identified from this systematic review was in tourism education, with nine studies. These studies examined how VR and AR could be adapted as a tool for learning in university tourism courses. Mikropoulos and Strouboulis (2004) hypothesized that presence is correlated to higher levels of cognitive performance and emotional development, factors that contribute to knowledge construction. In their adaptation, the

environmental richness and high level of interactivity attributed to VR, resulted in a higher degree of presence amongst all participants. Thus, they concluded that optimal adaptation of VR in education would lead to improved knowledge construction. In tourism education, the ability to simulate scenarios and facilitate interactivity in a virtual environment bodes well with the current push towards e-learning. A highlight from the literature was Hsu (2012)'s study on using the virtual world Second Life as a training tool for future tour leaders. Educators took students on tours of recreated real world monuments inside the virtual world, before letting the students experience being tour leaders themselves. This is a form of experiential learning that could not have existed before the rise of VR without flying around the world to experience these tourist attractions first-hand. Enjoyment and increased motivation of students were observed in the studies that had empirical data (Deale, 2013; Hsu, 2012; Huang, Backman, Chang, et al., 2013). However, the studies also highlighted significant challenges for the general adoption of the technology. Hsu (2012) warned that the different levels of technical literacy amongst users means that extra effort has to be invested into learning the platform. To ensure each experience goes as planned, the tutoring and guiding necessary for both teachers and students beforehand, will be time-consuming. Participants in Deale (2013)'s study labelled the Second Life platform cumbersome and also noted the time commitment involved to efficiently use the platform as challenges. The challenges echo those highlighted in past systematic literature reviews in education research (Akçayır & Akçayır, 2017; Kurilovas, 2016) and signals the importance of continued research in this tourism sub-sector.

4.2.3 Research on AR as a Tourism Experience Enhancement

The tourism experience enhancement category was exclusively made up of studies on AR. Seven studies (Chu, Lin, & Chang, 2012; Dueholm & Smed, 2014; Jung et al., 2015; Lalicic & Weismayer, 2015; Mesároš et al., 2016; tom Dieck et al., 2016; Trojan, 2016) focused on how AR enhanced the tourism experience at actual tourism locations. Some examples included exploring AR as an information dissemination tool in museums (Dueholm & Smed, 2014) or as location guides (Chu et al., 2012; Trojan, 2016). This could be explained by the more mobile nature of AR when compared to VR, which typically requires the user to be stationary and requires more processing power. This review also found that AR, in the context of being a tourism experience enhancement, has been gaining traction in the heritage and museum setting. In settings where there is large disseminations of information such as art galleries and museums, the use of AR was well received (Dueholm & Smed, 2014; tom Dieck & Jung, 2015). Participants in Dueholm and Smed (2014)'s study of AR acceptance in a Danish museum embraced the use of AR as an information interpretation tool, finding it novel and more interactive. However, much like Akçayır and Akçayır (2017)'s systematic review of AR in education, a common concern was ease-of-use (Dueholm & Smed, 2014; Jung et al., 2015). Dueholm and Smed (2014) also found some heritage site managers unwilling to embrace AR with concerns about diluting objective authenticity of the sites. Objective authenticity implies that authenticity lies in the toured object and can be measured with absolute and objective criteria. As AR environments and experiences are computer-generated reconstructions, heritage managers felt that these 'copies' contributed to weakening the absolute and objective criteria which toured objects were otherwise measured on. Quality of content emerged as the biggest requirement, whether it was using AR as a city guide or in museums (Dueholm & Smed, 2014; Jung et al., 2015; tom Dieck & Jung, 2015). More research into the user experience is needed and in particular, the issue of usability as a factor for destination managers' intention to use and tourist' intention to visit or revisit is warranted.

4.2.4 VR and AR Research in F&B and MICE

In this review work, two studies on Food & Beverage (F&B) were identified (Georgakopoulos, 2008; Hwang, Yoon, & Bendle, 2012). Georgakopoulos (2008) explored the benefits of increased immersion and interactivity for food safety training in F&B settings. He found that the ability to simulate and repeat dangerous situations, such as identification and assessment of hazardous foodborne diseases, within the virtual experience were the most valuable facets. Hwang et al. (2012) used VR as a methodological tool for examining crowding effects in a restaurant and found it useful for simulating controlled situations. However, in both studies, the authors felt that due to software limitations, such as the inability to realistically simulate human emotional responses, they could not yet recommend using VR over the real-world counterparts.

Despite early conceptual papers discussing the benefits that VR would potentially bring to MICE, there were only two studies in this category (Gustafson, 2012; Pearlman & Gates, 2010). The lack of research is surprising, considering early conceptual discussions hypothesizing potential applications such as revolutionising business travel, long-distance meetings, and large-scale conventions by holding them in virtual spaces; or planning, simulating, and sharing events within a virtual environment, which potential clients and consumers can explore and interact with (see Guttentag, 2010; Williams & Hobson, 1995). The two studies on MICE discussed the feasibility of virtual events as a strategy to save delegates travel time and costs (Gustafson, 2012; Pearlman & Gates, 2010). However, Pearlman and Gates (2010) found that businesses are apprehensive and still see VR/AR in the MICE sector as a fad rather than the future. In a later study on meeting planning for generation Y audiences, Sox, Kline, and Crews (2014) found perceived effectiveness to be a major barrier to virtual meeting adoption. It should be noted, considering the rapid rate of technological expansion, that these findings may not be currently relevant; signalling potential avenues for researchers to revisit, in light of VR/AR's growing prevalence. Gustafson (2012) found that the transition to virtual meetings in place of business travel involved a complex mix of policies, contractual agreements with travel agencies, feedback and sanctions, within and between organizations. He advocated future research on the interplay between corporeal and virtual mobilities, suggesting that the shift to virtual will have important implications on the roles of travel managers as well as the business travel market. Both studies focused on virtual events as replacements for corporeal travel. The results show that the perceived usefulness of VR/AR is still insufficient for industry-wide adoption, thus warranting continued research into the needs of the industry. However, gaps in avenues such as VR/AR as an event planning tool, giving clients previews of an event hall configured for events such as weddings or trade shows, remain unexplored. There is an avenue for future research here with potential to be a catalyst for change in the MICE industry.

4.2.5 VR and AR Research in Other Categories

Six of the 46 papers in this systematic literature review do not fit into the previous five categories because they focused on utilising VR/AR for particularly specific purposes such as replacing corporeal travel, job recruitment, and replacing corporeal sport tourism. These six papers however have valuable contribution to the development of VR/AR research. From the conceptual studies in the review, early discussions warned of VR eventually threatening physical and corporeal travel (Cheong, 1995). On the contrary, there was also the suggestion that VR would be the solution to sustainable tourism (Dewailly, 1999). Despite the discussion on the threat of VR, no study has empirically explored the extent of this 'threat'. In the one study that explored virtual tourism, Tavakoli and Mura (2015) studied Second Life as a way for Iranian women to travel and break social stigmas, framing virtual worlds as the destination. Their study did not confirm the threat to corporeal tourism as the women would not have been able to physically or independently travel to

their chosen locations anyway due to social stigma. In fact, no study in the review can confirm this threat of VR. The lack of research in this area can perhaps be attributed to the insufficient perceived authenticity of the technology currently available (Mura et al., 2016). Nevertheless, the importance of future research into virtual tourism lies in the benefits that it could bring to those that have restrictions on travel, such as physical disabilities, financial difficulties, or social stigma (Sung, Lee, Kim, Kwon, & Jang, 2000).

In his conceptual paper, Dewailly (1999) discussed VR/AR as a potential major contributor to sustainability in tourism. The only study on sport tourism in this review positioned VR golf as a sustainable alternative to real golf. Han et al. (2014) explored the decision-making process of screen-golf participants and the ecological benefits that VR could bring to what is traditionally a very resource-intensive sport. Their study found that advancements in screen golf proved a viable sustainable alternative to participants, with the added benefits of being both more accessible and budget-friendly. However, as sport is typically more corporeal and relies on simulation of more senses than the other tourism sub-sectors, bringing VR/AR alternatives into other sports remains a technological challenge.

Ultimately, the gaps and challenges identified in all the lesser researched categories appear to converge around the limitations of the VR/AR technology currently available. Many of these studies attempt to utilise VR/AR platforms for purposes in which they are not optimised for. For example, Second Life is a platform designed for entertainment. Trying to hold job recruitment fairs (Zelenskaya & Singh, 2011) or have virtual meetings in that platform poses technical challenges and workarounds that would not have otherwise been an issue in a purpose-made application.

4.3 Methodology in VR and AR Tourism Research

One of the research questions in this review was: *What methodologies are being utilised to study VR and AR in tourism research?* With calls for more empirical research (Tavakoli & Mura, 2015), Tables 5 and 6 provide an overview on the methods utilised in studies thus far.

[Table 5 near here] [Table 6 near here]

From Table 5, conceptual papers are the most common type of articles (28.26%). These consisted not only of papers discussing the implications of VR/AR, but also included papers where the authors were developing fledgling applications and early frameworks. Quantitative surveys were the most common form of data collection. Studies where the participants were given a demonstration of the technology before answering a questionnaire (23.91%) was the second most common and studies where participants answered questionnaires without being given demonstrations of VR/AR was third (7 studies). These were followed by qualitative methods where participants were interviewed without (6 studies) and with hands-on demonstrations of VR/AR (4 studies). Tavakoli and Mura (2015) argued that too many articles focused on discussions of future applications without empirical data to ascertain tourists' real experiences but Table 6 evidenced that more of the studies had empirical data (72%) than not.

4.4 Theory-based VR and AR Tourism Research

The fourth research question in this review was: *What theories are being utilised to study VR and AR in tourism research?* Firstly, Table 7 validates Huang et al. (2016)'s claim that there needs to be more substantive and theory-based research. As shown below, many studies in VR/AR were focused on applied research and prototype development, with little consideration for underpinning theories, concepts or frameworks.

[Table 7 near here]

Only 11 of the studies had theories present with the remaining 76% of studies not having any theories or concepts in the paper. Of the 11 papers, three adopted the *Technology Acceptance Model* (Huang et al., 2016; Huang, Backman, Backman, et al., 2013; Singh & Lee, 2009), two adopted the *Theory of Planned Behaviour* (Han et al., 2014; Huang et al., 2010), a further two adopted *Flow Theory (Huang et al., 2012; Lee & Jeong, 2012).* Another paper adopted *Self Determination Theory* (Huang, Backman, Chang, et al., 2013). The *Delone and McClean Information Systems Success Model* and the *Virtual Learning Environments Theory* were used by Jung et al. (2015) and Haven and Botterill (2003) respectively. Dueholm and Smed (2014)'s study was underpinned by the concept of *Authenticity*. The current lack of substantive and theory-based research in VR/AR tourism studies can be explained by the nature of the field which is still very much in the exploratory stage with a lack of established theories (Edmondson & McManus, 2007). Regardless of the tourism sub-sector, studies on VR and AR to a large extent attempt to understand consumer usage behaviours to then optimise and adapt the technology for the different uses.

The *Technology Acceptance Model* (TAM) theorises that Perceived Usefulness and Perceived Ease of Use determine intention to use, which then leads to usage behaviour (Davis, 1989). Whilst the only study that utilised the concept of *Authenticity* in the review adapted it for AR, exploring perceptions of authenticity could provide valuable insights into the trajectory of virtual tourism. Mura et al. (2016) found that their participants regarded virtual tourism in its current form as not authentic enough and thus not viable as a replacement for corporeal tourism. An adequate level of authenticity perceived from virtual worlds could prove to be the tipping point for an influx of interest, both academically and from the tourism industry, into virtual tourism. Outside tourism, *Presence Theory* has been adapted for VR research in education (Sun, Li, Zhu, & Hsiao, 2015), aviation (Vora et al., 2002), computer-mediated conferences (Gunawardena & Zittle, 1997), and emotional environments in cyberpsychology (Banos et al., 2004). The concept of Presence is the perceptual illusion that a mediated experience is not mediated (Bartle, 2007; Dinh, Walker, Hodges, Chang, & Kobayashi, 1999). Presence Theory identifies involvement and immersion as two primary characteristics that enhance the user experience in a VR environment. The above studies all found higher presence led to higher efficiency for the participants. Sun et al. (2015) also found that immersion was dependent on time spent in the VR experience and recommended longer sessions for the user to have a higher sense of immersion and thus, presence. *Motivation Theory* is another that has been used to study AR's impact on student behaviour (Di Serio, Ibáñez, & Kloos, 2013). Adapting this for a tourism context could provide important insights to the influence of VR/AR on travel motivation. Considering VR/AR's purported effects toward stronger cognitive and emotional responses (Mikropoulos & Strouboulis, 2004), *Cognitive Appraisal Theory* (Lazarus, 1991; Skavronskaya et al., 2017) could also be considered. In particular, it would be interesting to explore the impact of immersion, interactivity, and visualisation on the dimensions of novelty, goal congruence, agency, and the resulting emotions and behaviour.

5.0 Conclusion

5.1 Summary

This study maps the current state of research on virtual and augmented reality in tourism. Through a systematic quantitative review of articles published in tourism and hospitality journals, the review synthesized 46 published studies into seven categories in which VR and AR research have emerged, and observed developments in terms of methodology and theory. Based on the findings from our review work, Figure 3 maps the key findings that have emerged from the review work, and consequently contributes to the literature on VR and AR in tourism in three major ways.

[Figure 3 near here]

5.2 Contributions

Firstly, one of the issues we identified in the 46 studies was with terminology used. Due to the nascent nature of research in VR and AR thus far; studies had used the terms virtual environment, virtual reality and virtual worlds inconsistently and often time, without including definitions of the terms. Kavoura and Bitsani (2013) for example, included virtual reality in their keywords and paper. However, the term was never defined and the study focused on e-branding without addressing the lack of visualisation, immersion or interactivity that generally defines VR (Guttentag, 2010; Williams & Hobson, 1995). With expected technological developments, and as more research focuses on specific facets of VR or AR, we urge future researchers to further define the terminology. Research where the focus includes aspects of visualisation, immersion, and interactivity should be clearly labelled and categorised as VR, moving away from the term virtual environment. As shown in the findings, the term virtual environment is too broad and includes online or virtual learning, online branding or servicescape, and virtual communities; none of which feature aspects of visualisation or immersion. Relatedly, we also identified a lack of awareness of the different platforms in several studies. It is critical that future scholars clearly and accurately define terminology for the areas of VR/AR they are researching to avoid confusion and to delineate the stream and scope of research within VR/AR in tourism.

A second major contribution of this review work is the identification of the gaps and challenges, and these revolve around four main themes: 1) awareness of the technology; 2) usability; 3) time commitment required to learn; and 4) the willingness to replace corporeal experiences with virtual ones. In particular, the challenge that consistently appeared were the technical difficulties that affected usability in various categories by tourists, students, educators, managers of tourism sites, and their employees. If potential consumers are not using the technology, any positive results will be negligible. Time commitment needed to ensure sufficient proficiency in utilising VR/AR was another consistent challenge identified from the studies in this review. This challenge was especially apparent in tourism education studies, where training time had to be devoted to ensuring educators were proficient in using VR/AR. The educators then had to ensure students were also proficient in using platforms like Second Life. Outside tourism education, destination marketers targeting families for example, will be highly unlikely to benefit from choosing virtual worlds like Second Life as their platform as a majority of parents are unlikely to commit the time and effort to learn how to use the platform.

A third significant contribution of this review is represented by Figure 4. The findings have highlighted the lack of theory-based research in VR and AR. To a certain extent, this is relatively unsurprising, considering the technology has only very recently emerged in the mainstream markets.

However, moving forward, we call for researchers to adopt more substantive theory-based research. From the review, usability was a common deterrent toward usage of VR/AR. Davis (1989)'s Technology Acceptance Model, in which ease-of-use is a key factor in determining usage behaviour, has been adapted successfully in the marketing and education contexts. An application of Presence Theory to contexts like destination marketing could provide key insights into the optimal time-range that VR experiences should be for the highest efficiency. Similarly, research in sub-sectors like MICE, where businesses are still resisting VR/AR, could benefit from adapting TAM, breaking down facets of ease-of-use and usability to explore the factors that could potentially drive usage. The research gaps uncovered by this review work has resulted in a conceptual framework for future research that is set within TAM (Figure 4). We wish to empirically explore this framework further in our continuing work on VR in tourism and hope to report on this in a subsequent paper.

[Figure 4 near here]

5.3 Future Research and Limitations

Tavakoli and Mura (2015) and Hine (2000) have called for more emphasis on empirical research of user experience rather than predictions of revolutionary futures for VR and AR in tourism. Insights into the different facets that influence perceived usability or perceived ease-of-use will be important in driving future development of the technology. A consideration for future research would be exploring the impact of introducing VR/AR booths in spaces like travel agencies and tourism information centres. This could potentially increase awareness of the technology amongst the general population whilst also removing the challenge of ease-of-use with an expert or guide-person on hand to offer assistance. Additionally, new research that aims at advancing the technology is necessary in building purpose-specific platforms that address many of the challenges presented in the studies. As seen in the synthesized studies, utilising VR/AR platforms for purposes in which they are not optimised for posed technical challenges and workarounds that would not have otherwise been an issue in a purpose-made application. Multidisciplinary studies bridging tourism, information technology, engineering, and psychology would provide valuable insights toward that aim.

Based on the studies in this review, both businesses and consumers were still largely hesitant in accepting virtual substitutes for corporeal experiences. Yet, we identified that in sport tourism, a purpose-made platform like virtual golf is gaining traction and is considered an acceptable alternative to real golf (Han et al., 2014). Future research on authenticity in virtual environments will be important alongside technical progression. When the perceived authenticity of virtual environments reaches an acceptable level, as Gustafson (2012, p. 283) posits, focus will shift from 'how to travel' to 'how to meet'. Especially in virtual tourism, the potential of overcoming physical and social restrictions presents an avenue that warrants pursuit. There are also future research avenues in virtual tourism like TV tours that could surpass the physical boundaries of corporeal travel. Relatedly, a consideration for future reviews would be to compare between conceptual studies and what happens in empirical studies or industry in future VR/AR applications.

From this systematic literature review, we posit that VR and AR have huge potential in the various sub-sectors of tourism. Whether it is in the context of education, marketing, cultural heritage or sustainability, the technology offers novel and interactive avenues for dissemination of information which have previously been impossible. The proposed conceptual framework (Figure 4) is relevant to and could be empirically tested in any of the contexts. An interesting finding was that most studies at the travel experience stage were based on AR. There are avenues for future researchers to explore the application of VR at travel destinations as part of the tourism attraction. Another major consideration for future research should be on 360' VR experiences, which is currently absent from

the review of literature. The emergence of 360' cameras alongside the various head-mounted displays indicates that the tools to both create and consume VR have moved out of the early adopter and developer phase. Anyone who owns a 360-degree camera can create VR experiences without the need to understand complex technical programming, signalling the potential exponential increase of VR content ready to be consumed. Social media platforms such as YouTube and Facebook readily support VR. Optimal adaptation of the technology could potentially usher in a new phase of destination marketing, holiday homes rental, and couchsurfing, combining aspects of virtual communities, entertainment, interactivity and novelty. Finally, researchers interested in virtual worlds and virtual tourism should pay attention to Linden Lab (2016)'s successor to Second Life, Sansar. Touted as the future for social VR experiences, the new platform will combine the interactivity of the Second Life virtual world, with the immersion of modern VR head-mounted displays. With the increased immersion, there are avenues of research to explore if platforms such as Sansar could potentially bridge the current lack of authenticity and presence needed for the impending arrival of virtual tourism.

While this study provides insights into the trajectory of VR and AR research in tourism, it also has limitations which future researchers should consider. In this systematic review, only English articles published in tourism and hospitality journals were targeted. Given that VR and AR is an emerging field of study and the considerable time taken for peer reviewed articles to appear in international journals, researchers may also wish to consider publications in international peer reviewed journals alongside conference papers, reviews, editorials, thesis, dissertations, and books. Taking into consideration studies published in other languages alongside a much larger base of data may produce differing results. Finally, while the systematic nature of the method has been explicitly outlined in the study, interpretation of the data remains relatively subjective. Nevertheless, the transparent and structured reporting practiced has made future follow-up studies possible.

Despite the limitations, this is the first systematic literature review of VR and AR research in tourism. This review has mapped the current state of research on VR and AR in the tourism industry and identified issues and considerations for future research to build upon. Although the review was not conducted with a focus on industry, the findings have managerial implications. For one, the benefits and impacts presented in the studies were usually encumbered by concerns of usability and costs. Destination marketers, travel agencies, and tour operators who have developed VR or AR experiences should have 'VR stations' available at their promotional sites with technical assistance at hand. This would remedy ease-of-use concerns and circumvent the financial concerns of having to purchase specialty devices to experience them. In addition, with this systematic, comprehensive view of the emerging advantages and challenges of VR and AR adaptation in tourism, universities, research institutes, and the industry have a clearer picture of the state of research and justification for increasing initiatives into VR and AR research.

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Table 1. The 46 articles used in the final synthesis.

Author	Date	Title
Williams & Hobson	1995	Virtual reality and tourism: fact or fantasy?
Cheong	1995	The virtual threat to travel and tourism
Dewailly	1999	Sustainable tourist space: From reality to virtual reality?
Bray	2002	Virtual tutoring in hospitality - a "learnt system" of professional practice
Cooper & Macneil	2005	Virtual Reality Mapping: IT Tools for the Divide between Knowledge and Action in Tourism
Singh & Lee	2009	Exploring Perceptions Toward Education in 3-D Virtual Environments: An Introduction to “Second Life”
Penfold	2009	Learning Through the World of Second Life - A Hospitality and Tourism Experience
Breukel & Go	2009	Knowledge-based network participation in destination and event marketing: A hospitality scenario analysis perspective
Georgakopoulos	2010	Food Safety training: A Model HACCP Instructional Technique
Kim & Hardin	2010	The Impact of Virtual Worlds on Word-of-Mouth: Improving Social Networking and Servicescape in the Hospitality Industry
Huang, Backman, & Backman	2010	Student Attitude Toward Virtual Learning in Second Life: A Flow Theory Approach
Pearlman & Gates	2010	Hosting Business Meetings and Special Events in Virtual Worlds: A Fad or the Future?
Guttentag	2010	Virtual reality: Applications and implications for tourism
Pantano & Servidio	2011	An exploratory study of the role of pervasive environments for promotion of tourism destinations
Zelenskaya & Singh	2011	Exploring Virtual Recruiting From Employers’ Perspective Using “Second Life”
Crick	2011	New Third Places: Opportunities and Challenges
Torchin	2012	Location, location, location: The destination of the Manhattan TV Tour
Hwang, Yoon, & Bendle	2012	Desired privacy and the impact of crowding on customer emotions and approach- avoidance responses: Waiting in a virtual reality restaurant
Huang, Backman, & Backman	2012	Exploring the impacts of involvement and flow experiences in Second Life on people's travel intentions
Gustafson	2012	Managing business travel: Developments and dilemmas in corporate travel management
Hsu	2012	Web 3D simulation-based application in tourism education: A case study with Second Life

Chu, Lin, & Chang	2012	mGuiding (Mobile Guiding) – Using a Mobile GIS app for Guiding
Gomezelj & Civre	2012	Tourism graduate students' satisfaction with online learning
Lee & Jeong	2012	Effects of e-servicescape on consumers' flow experiences
Guillet & Penfold	2013	Conducting Immersive Research in Second Life: A Hotel Co-Branding Case Study
Huang, Backman, Chang, Backman, & McGuire	2013	Experiencing student learning and tourism training in a 3D virtual world: An exploratory study
Deale	2013	Incorporating Second Life into online hospitality and tourism education: A case study
Huang, Backman, McGuire, Backman, & Chang	2013	Second Life: The potential of 3D virtual worlds in travel and tourism industry
Huang, Backman, Backman, & Moore	2013	Exploring user acceptance of 3D virtual worlds in travel and tourism marketing
Kavoura & Bitsani	2013	E-branding of rural tourism in Carinthia, Austria
Haven & Botterill	2013	Virtual Learning Environments in Hospitality, Leisure, Tourism and Sport: A Review
Pedrana	2014	Location-based services and tourism: possible implications for destination
Mascho & Singh	2014	Virtual tourism: use of "second life" for destination marketing
Dueholm & Smed	2014	Heritage authenticities – a case study of authenticity perceptions at a Danish heritage site
Whittington	2014	Family Vacation 2050: Socially and Technologically- Driven Scenarios of the Future of Family Travel, Recreation and Tourism
Han, Hwang, & Woods	2014	Choosing Virtual – Rather than Real – Leisure Activities: An Examination of the Decision–making Process in Screen-Golf Participants
Dias, Correia, & Lopez	2015	The meaning of rental second homes and places: the owners' perspectives
Kim, Jang, & Adler	2015	What drives café customers to spread eWOM?: Examining self-relevant value, quality value, and opinion leadership
Jung, Chung, & Leue	2015	The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park
tom Dieck, Jung, & Han	2016	Mapping requirements for the wearable smart glasses augmented reality museum application
Trojan	2016	Integrating AR services for the masses: geotagged POI transformation platform

Huang, Backman, Backman, & Chang	2016	Exploring the Implications of Virtual Reality Technology in Tourism Marketing: An Integrated Research Framework
Lalicic & Weismayer	2016	The passionate use of mobiles phones among tourists
Luo & Zhang	2016	Building interpersonal trust in a travel-related virtual community: A case study on a Guangzhou couchsurfing community
Tavakoli & Mura	2016	'Journeys in Second Life' - Iranian Muslim women's behaviour in virtual tourist destinations
Mesaros, Mandicak, Mesarosova, Hernandez, Krsak, Sidor, Strba, Molokac, Hvizdak, Blistan, & Delina	2016	Use of Augmented Reality and Gamification techniques in tourism

Table 2. Journal distribution of the 46 articles.

Journals	**No. of Studies**	**%**
Tourism Management	9	19.57
Journal of Hospitality and Tourism Technology	5	10.87
International Journal of Contemporary Hospitality Management	3	6.52
Journal of Teaching in Travel and Tourism	3	6.52
Tourism	3	6.52
Journal of Hospitality, Leisure, Sport, and Tourism Education	3	6.52
Tourism Geographies	2	4.35
Tourism Recreation Research	2	4.35
Journal of Hospitality Marketing & Management	1	2.17
Journal of Convention & Event Tourism	1	2.17
Journal of Human Resources in Hospitality & Tourism	1	2.17
Advances in Culture, Tourism and Hospitality Research	1	2.17
Tourist Studies	1	2.17
Scandinavian Journal of Hospitality and Tourism	1	2.17
International Journal of Hospitality & Tourism Administration	1	2.17
Journal of Hospitality, Leisure, Sport, and Tourism Education	1	2.17
Tourism Analysis	1	2.17
Current Issues in Tourism	1	2.17
Anatolia	1	2.17
Journal of Heritage Tourism	1	2.17
Asia Pacific Journal of Tourism Research	1	2.17
International Journal of Tourism Research	1	2.17
Information Technology and Tourism	1	2.17
e-Review of Tourism Research	1	2.17
Total	**46**	**100.00**

Table 3. Summary of the types of VR or AR in tourism and hospitality research.

Type of VR	**No. of Studies**	**%**
Virtual Worlds	18	39.13
Virtual Environments	11	23.91
Augmented Reality	8	17.39
Virtual Reality	6	13.04
Virtual Communities	3	6.52
Total	**46**	**100.00**

Table 4. Categories of VR and AR studies in tourism and hospitality research.

Context	**No. of Studies**	**%**
Marketing	13	28.26
Education	9	19.57
Conceptual	7	15.22
Tourism Experience Enhancement	7	15.22
Food & Beverage	2	4.35
Meetings, Incentives, Conferences and Events	2	4.35
Others	6	13.04
Total	**46**	**100.00**

Table 5. Summary of methodologies used in the 46 papers.

Methodology	**No. of Studies**	**%**
Conceptual Paper	13	28.26
Survey with Demonstration	11	23.91
Survey	7	15.22
Interviews	6	13.04
Interviews with Demonstration	4	8.70
Action Research	1	2.17
Scenario Analysis	1	2.17
Content Analysis	1	2.17
Mixed Methods	1	2.17
Netnography	1	2.17
Total	**46**	**100.00**

Table 6. Summary of presence of empirical data in the studies.

Empirical Data	**No. of Studies**	**%**
Y	33	71.74
N	13	28.26
Total	**46**	**100.00**

Table 7. Summary of presence theories in the studies.

Theories Present	**No. of Studies**	**%**
N	35	76.09
Y	11	23.91
Total	**46**	**100.00**

Figure 1. Simplified representation of a RV continuum (Milgram et al., 1994, p. 283).

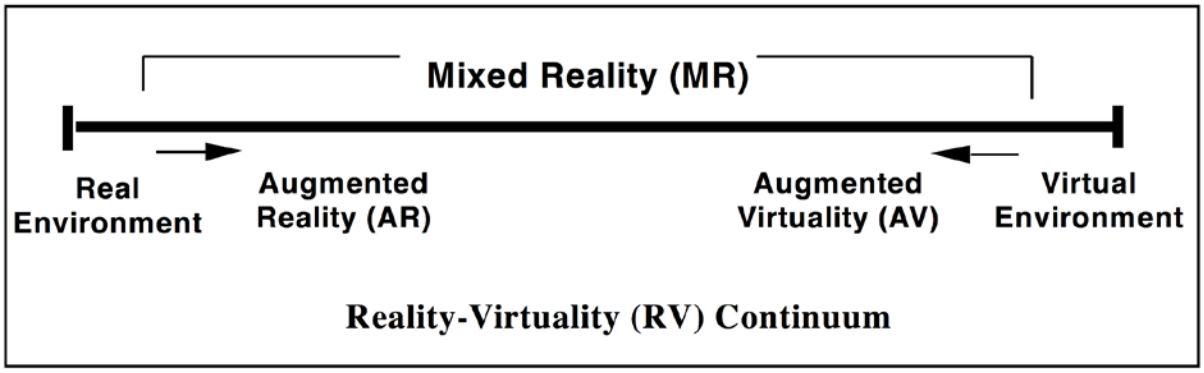

Figure 2. Summary of systematic quantitative review research process. Source: Yang et al. (2017)

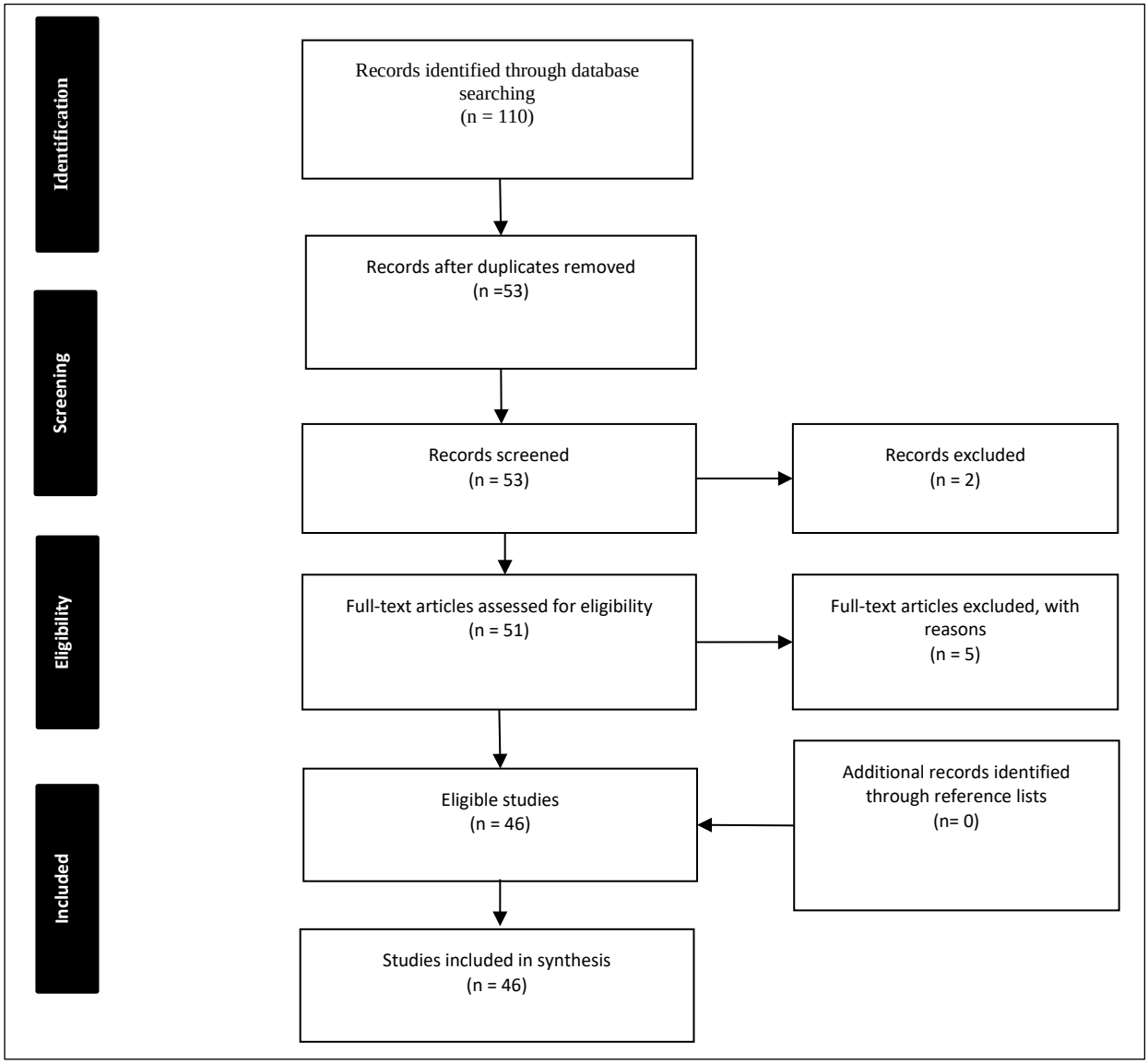

Figure 3. Summary of key findings.

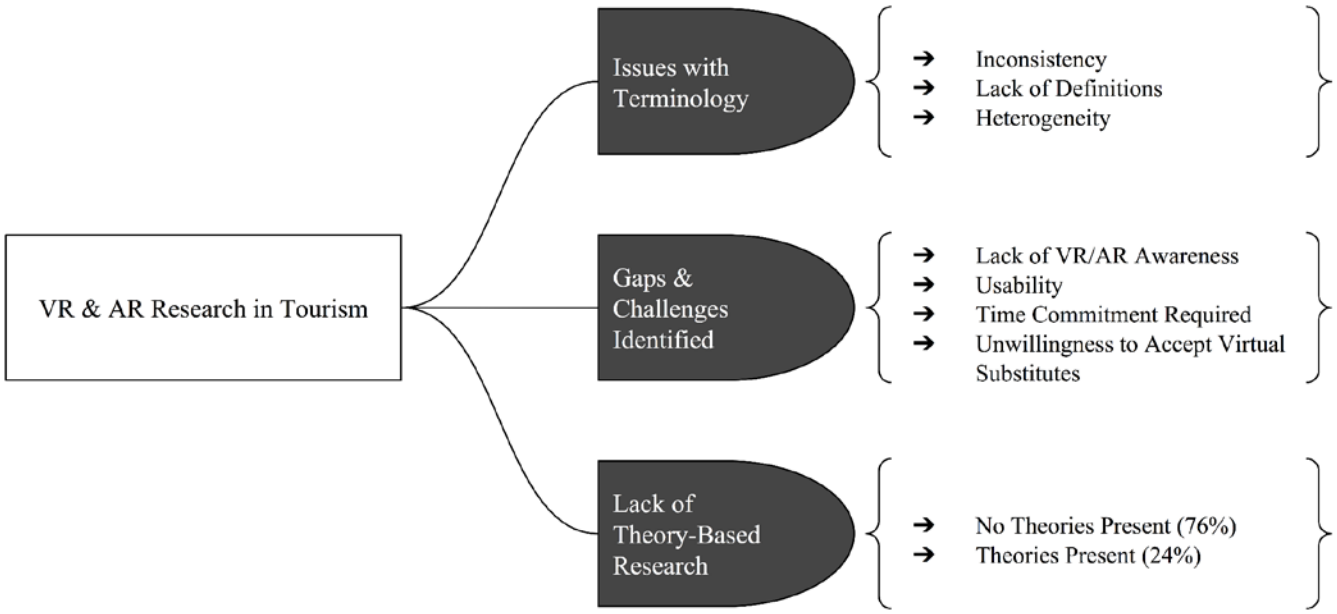

Figure 4. Conceptual model of challenges to VR adoption for tourism within TAM framework.