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# Augmented reality and experience co-creation in heritage settings

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**ABSTRACT**

Augmented reality (AR) is being adopted at heritage settings as a means of creating and delivering experiences for heritage visitors. While several studies have examined AR applications and the antecedents and consequences of their employment from a consumer perspective, the heritage supplier's view in relation to how AR applications are designed remains underexplored. We explore the way heritage suppliers utilise AR for heritage settings, and as an interpretive medium that induces experience co-creation among visitors. Drawing on insights gained from interviewing heritage experts, the findings shed light on the virtual and physical experience elements included when designing AR. Five techniques employed by heritage producers that facilitate experience co-creation through AR are revealed: social interaction, personalisation, storytelling, gamification, and participation. Opportunities and implications of AR for sectors beyond heritage are then discussed.

## Introduction

Immersive technologies and their developing capabilities to form realistic virtual assets have accelerated the adoption of augmented reality (AR) in consumer experiences (Javornik, 2016; Rauschnabel, 2021). Considering its ability to visualise tangibly unavailable elements, museums and heritage locations have increasingly invested in and employed AR – defined as a technological medium that allows virtual assets to be superimposed on the physical world, typically with the assistance of technical hardware equipped with a camera (Suh & Prophet, 2018). For instance, The National Gallery, National Portrait Gallery and the Royal Academy of Arts collaborated to create an AR trail across the City of London *(Art of London Augmented Gallery, 2018)*. Other AR projects connecting individuals to history have also been initiated, such as by the Kyoto National Museum and the Smithsonian (Hansen, 2018; *New Augmented-Reality Experience Spotlights Human Connection to the Oceans*, 2021). In parallel, academic research has responded to facilitate understanding of such applications, with an increasing number of studies exploring and analysing the ways that AR can be incorporated successfully in heritage tourism (Guttentag, 2010; Tom Dieck & Jung, 2018; Verhulst et al., 2021).

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From the technical and computer science perspectives, studies have looked at how to develop realistic and useful heritage AR experiences (Zhao et al., 2019), using different kits to create the software (Benyon et al., 2014), and have addressed the challenges that arise when trying to reconstruct historical ruins in an outdoor setting (Hadley et al., 2018). We also know that use of AR can enhance the learning processes and amplify entertaining visitor experiences, through Suh and Prophet's (2018) comprehensive review of immersive technologies. However, studies exploring AR in heritage tourism have favoured a demand perspective, almost exclusively utilising an objective, causal approach. Insights from such research infer that visitors to heritage settings have a positive attitude towards AR, and find value in using the technology during their experiences (Chung et al., 2018; He et al., 2018; Jung et al., 2015; Trunfio & Campana, 2020; Verhulst et al., 2021). Furthermore, the entertainment and educational aspects of AR are highly appreciated by museum visitors, often determining the visitor's satisfaction with the technology (Jung et al., 2016; Tom Dieck & Jung, 2017). However, little is known about the heritage producer's perspective towards AR. Visitors to heritage sites are known to place importance on the aesthetics, usability, content quality, and personalisation when using AR (Chung et al., 2018; Jung & Tom Dieck, 2017; Lee et al., 2015). Even in 'experiencescapes' that immerse consumers without the use of complex technology, the design dimensions of the experience are considered integral for value creation (Edvardsson et al., 2005). This raises the need to understand what the heritage producers considerations are when designing the virtual environment of the AR experience. The importance of this exploration is solidified on realising the unique experience co-creation opportunities that AR provides.

Experience co-creation is the process wherein consumers and organisations collaborate and integrate resources to form experiences. The process is considered to be beneficial for both actors, and generally assigns the consumers as active participants (Buonincontri et al., 2017). Within a general heritage setting, extant producer-side research offers an indication of how experience is co-created. Specifically, there is evidence that producers cocreate museum experiences through different means such as storytelling, artefact provision, and indexical and iconic authenticity depiction (Thyne & Hede, 2016) and that tour guides also use a combination of resources to enhance facts with tourists' own interpretation (Ross, 2020). While storytelling is key in the process of cocreation, the literature has emphasised the role of the producer in producing different means of cocreation, which are participatory in nature (Ross & Saxena, 2019).

It is known that additional opportunities for such collaboration are made available for both the organisation and consumer when technologies are introduced into the process. According to Neuhofer (2016), co-creation is dependent on the intensity of the technology and the level of involvement of the user, and Buonincontri et al. (2017) note that smart technologies improve the co-creation of experiences by encouraging enterprise and tourist interactions, increasing tourists' active participation, and foster the sharing of experiences among various tourists. Much research has been conducted in this vein, understanding the routes that establish effective experience co-creation from a consumer viewpoint. However, there is a need to further understand how the suppliers are utilising this information about customer interactions to design the technologies and involve all parties in the experience (Larivière et al., 2017; Ramaswamy, 2005). This importance of the firm has also been highlighted by Jaakkola et al. (2015) in a broader

service setting, noting a control dimension of service experience co-creation, recognising that experience co-creation can be led by the providers.

Specifically, regarding AR, the experiences that consumers engage in take place in an environment with virtual assets, a space we can term the 'virtually enhanced environment'. The content included in the virtually enhanced environment is found to direct consumers' experiences, including influencing their enjoyment and involvement with the AR (Javornik et al., 2019). In heritage, this aspect leads to a concern that the producer is often the guiding force of experiences and has tremendous control over the information that is presented. In fact, staging by the supplier is considered vital for visitors to initiate the consumption experience (Chronis, 2008). Producer-side research highlights AR's multiple possibilities, including its ability to create different types of value for its various stakeholders (Cranmer et al., 2020; Jung & Tom Dieck, 2017). It has also been noted that visitors prefer guidance from producers, achieving engaging and memorable experiences, underwritten by historical and archaeological expertise (Minkiewicz et al., 2014). If the virtually enhanced environment is created by the producers, for settings where such direction is valued by the consumer, then we need to know more about how the AR designing process is carried out, and whether, and importantly, how AR has the potential to generate experience co-creation.

Hence, this paper seeks to identify the manner in which the virtually enhanced environment is conceived and to outline how AR can enable heritage producers to create experience co-creation opportunities for visitors. To achieve this, we obtain and analyse insights from heritage producers previously involved in deploying completed AR experiences. The work is structured accordingly: We first set the theoretical background of this research by reviewing the literature covering AR and its design, and applications of AR in heritage are also presented, along with the importance of including the appropriate AR elements. We also include relevant knowledge about experience co-creation and technology, followed by the current understanding of producers' contributions in leading the co-creation of heritage experiences. Next, we present the methodological approach employed and the analytical foundations. Subsequently, the results are shared, which present a conceptualisation of the elements in the virtually enhanced environment, as well as their intended role in inducing experience co-creation. We then proceed to the discussion of theoretical and managerial contributions from this research and suggestions for future research.

## Theoretical background

### *Augmented reality & designing*

AR is a type of immersive technology, with its primary feature being the ability to combine physical and virtual worlds in real time in an interactive, 3D manner, and consequently, to provide a sense of user immersion (Cranmer et al., 2020). Commonly AR can be controlled and directed through devices such as smartphones, wearable apparatus (glasses) or stationary panels and displays (Scholz & Smith, 2016). However, mobile AR is commonly utilised for consumer use due to its familiarity and easy accessibility on most smartphones (Casella & Coelho, 2013). Applications of AR for heritage settings have similarly preferred

mobile AR, allowing visitors to explore locations with constant availability of the technology.

Examples of these are provided in Table 1, presenting key studies that have researched such applications of AR in heritage. This confirms the previously presented notion that explorations in this area have favoured a demand-side, positivist approach, often focusing on visitors' responses to the technology. In addition to the studies presented in Table 1, current research has also provided insight into the value of AR in heritage, as well as an understanding of its different applications.

For instance, Jung and Tom Dieck (2017) conducted case study-based research in a museum, recommending AR be utilised to co-design experiences, create signature moments or design digital souvenirs. Hesitation from the provider side was also uncovered, and was attributed to limited spending capabilities, and reduced personal interaction among consumers; however, literature shows supplier sentiments to be generally positive towards adopting AR due to the potential competitive advantage, enhanced consumer attention and ability to gather consumer data.

Another manner in which AR has been used in heritage experiences is by including aspects of gamification. Referred to as using the mechanics of game elements to design non-game contexts, gamification often involves including reward systems, chronological stages of progression and aspects of competition (Suh & Prophet, 2018). Furthermore, gamification has also been identified to lead to co-creation behaviours among consumers, assisting organisations in creating new products, that can lead back to engaging consumers (Leclercq et al., 2017).

This leads to a recognition of the importance of making informed decisions in relation to consumers when designing AR and has also been highlighted by previous research. For instance, Scholz and Smith (2016) underscored the need for marketers to understand the building blocks of AR in order to create immersive experiences for consumers. Their conceptualisation identified two ingredients of AR – active ingredients (consumers), and passive ingredients (bystanders, real-world background). Being situated in the retail marketing sphere, Scholz and Smith's study made design recommendations concerning content and communication. It also suggested the value of planning how AR integrated with special and physical contexts. In a vein more relevant to our research, Javornik et al. (2019) studied the types of content that function well with AR in an outdoor setting, finding that utilising both image and textual content was the most successful approach for users' enjoyment with the app, recommending that precise design solutions are required when developing AR. He et al. (2018) similarly investigated the effects of AR design elements on visitors' museum experiences, pointing out that few studies have explored AR designing processes and the subsequent consumer behaviours.

Next, the concept of experience co-creation is introduced, along with a discussion of the value in understanding a supplier's perspective.

### *Experience co-creation*

Developments in the experience mindset and S-D logic have resulted in research that explores and attempts to understand experience co-creation on a granular level, primarily focusing on the behaviours of consumers co-creating, their antecedents and consequences (Jaakkola et al., 2015). It is important to remember, however, that co-creation

**Table 1.** Key studies exploring AR and experience co-creation in heritage.

| Study | Perspective | AR | Experience Co-creation | Methods | Context | Findings |
|---|---|---|---|---|---|---|
| Chronis (2008) | Consumer | - | ✓ | Qualitative | Heritage Consumption | Recognised that the narrative experiencescape for heritage consumption is co-constructed, and is a product of:<br>• Narrative staging by producers (substantive and communicative)<br>• Narrative following by visitors (prior knowledge; filling gaps; re-contextualising; imagining)<br>• Authentication<br>• Contestation |
| Minkiewicz et. al (2014) | Consumer | - | ✓ | Qualitative | Heritage Consumption | Co-creation of consumption experience explored in a heritage setting, revealing three facets of co-creation: co-production, engagement and personalisation. |
| Chung et al. (2015) | Consumer | ✓ | - | Quantitative | Heritage Consumption | Users' technology readiness, AR's visual appeal, and facilitating conditions have a significant effect on users' intention to use AR and intention to visit a heritage site. |
| Jung et al. (2015) | Consumer | ✓ | ✓ | Quantitative | Hospitality & Tourism | Dimensions of content quality, systems quality and personalised service affected user satisfaction and intention to recommend AR applications. |
| Tscheu and Buhalis (2016) | Producer | ✓ | ✓ | Qualitative | Heritage Consumption | Value creation process by AR in heritage requires integration of three stages:<br>• Producer Requirements<br>• Development Stage (where importance of co-creation is noted)<br>• Benefits and Costs for Providers and Users |
| Thyne and Hede (2016) | Consumer and Producer | - | ✓ | Qualitative | Heritage Consumption | Experiences co-produced by visitors using:<br>• Skills<br>• Knowledge<br>• Past experience<br>• Sense of nostalgia<br>• Devotion to subject of historical siteRole of museum in experience co-production:<br>• Expert storytelling<br>• Provision of artefacts<br>• Indexical/iconic authenticity portrayal |
| Buonincontri et al. (2017) | Consumer | - | ✓ | Quantitative | Heritage Consumption | Studied the antecedents and consequences of experience co-creation in tourism, recognising the role of the provider and accompanying tourists.<br>Antecedents of Experience Co-creation:<br>• Tourist and Provider Interaction<br>• Active Participation<br>• Sharing experience with tourists (not supported)<br><br>Consequences of Experience Co-creation:<br>• Satisfaction<br>• Willingness to Spend on experience<br>• Happiness with the experience |

(Continued)

**Table 1.** (Continued).

| Study | Perspective | AR | Experience Co-creation | Methods | Context | Findings |
|---|---|---|---|---|---|---|
| Tom Dieck and Jung (2017) | Producer | ✓ | - | Qualitative | Heritage Consumption | Perceived value of AR for cultural heritage organisations:<br>• Economic<br>• Experiential<br>• Social<br>• Epistemic<br>• Historical and Cultural<br>• Educational |
| Chung et al. (2018) | Consumer | ✓ | - | Quantitative | Heritage Consumption | Investigated the causal mechanisms underlying consumers' beliefs about AR by utilising balance theory, theory of reasoned actions, post-acceptance model of information systems. Findings showcased that satisfaction with AR, results in users having positive attitude towards the AR, and ultimate intention to revisit destination. |
| He et al. (2018) | Consumer | ✓ | - | Quantitative | Hospitality & Tourism | AR design elements of information type and environment augmentation were found to have influenced visitors' museum experience, and ultimately, their willingness to pay for an art museum experience. |
| Ross and Saxena (2019) | Consumer and Producer | - | ✓ | Qualitative | Archaeological Tourism | Co-creation was found to be actor focused, participative, involving meaning co-construction and adapted based on organization. |
| Ross (2020) | Producer | - | ✓ | Qualitative | Heritage Consumption | Tour guides engage tourists' operant resources by encouraging:<br>• Tourist interaction with primary evidence<br>• Tailoring to tourists' interest<br>• Encouraging questions and critical interpretationParadoxically, guides underline the authorized discourse, resulting in disintegration of the co-creative process. |
| Cranmer et al. (2020) | Producer | ✓ | - | Qualitative | Heritage Consumption | Perceived value of AR for tourism:<br>• Marketing<br>• Economic<br>• Tourist<br>• Epistemic<br>• Organisational |
| Do et al. (2020) | Consumer | ✓ | - | Quantitative | Hospitality & Tourism | Utilising technology Acceptance Model (TAM), Stimulus-Organism-Response (SOR) and flow theory, findings showcase that mobile AR apps users' impulse to buy is influenced by perceived usefulness, perceived ease of use and perceived interactivity. |
| Alexiou (2020) | Consumer | - | ✓ | Qualitative | Heritage Consumption | Developed a 'Context-Interaction-Feelings' model that conceptualises a multi-faceted cultural heritage festival experience. Co-creation was found to occur through attendees' participation, immersion and inter-consumer interactions. |

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**Table 1.** (Continued).

| Study | Perspective | AR | Experience Co-creation | Methods | Context | Findings |
|---|---|---|---|---|---|---|
| Yin et al. (2021) | Consumer | ✓ | - | Qualitative | Hospitality & Tourism | Explored tourists' involvement in co-creating experiences, identifying that tourists prefer to be involved in the decision-making system of the AR experience. Contributing in this manner was also found to satisfy tourists' needs for self-actualisation and empowerment. |
| **This Research** | Producer | ✓ | ✓ | Qualitative | Heritage Consumption | Explored heritage suppliers' views towards adopting AR, and their approaches towards inducing experience co-creation. The 'virtually enhanced environment' is introduced, which informs the symbiotic relation required between virtual and real-world elements when utilising AR. Certain techniques that are assumed by the producers with the intention to induce experience co-creation are recognised: social interaction, personalisation, storytelling, gamification and participation. |

includes collaboration between customers, managers, or other stakeholders. In their original conceptualisation, Prahalad and Ramaswamy (2004) note that the firm is an entity that facilitates the creation of experience-based value from interactions with consumers. The firm as a stakeholder that facilitates experience co-creation has not been sufficiently studied in literature, with further research required that attempts to understand contexts in which a collaborator of co-creation may be required (Jaakkola et al., 2015; McColl-Kennedy & Cheung, 2018).

Accordingly, for the purposes of this paper, the comprehensive definition by Jaakkola et al. (2015, p. 193) of service experience co-creation is utilised as a guide for the meaning of experience co-creation within a heritage setting – service experience co-creation occurs when interpersonal interaction with other actors in or beyond the service setting influences an actor's subjective response to or interpretation of elements of the service. It may encompass lived or imaginary experiences in the past, present or future, and can occur in interaction between the customer and provider, other customers, and/or other actors. This approach towards experience co-creation allows the following: the recognition of multiple stakeholders and the inclusion of assets held by the organisation, including technology (Akaka & Vargo, 2014; Richards, 1996).

### Heritage producer facilitated co-creation

Heritage consumption involves a deep aspect of education and learning, leading to consumers preferring a greater degree of producer presence in this context in order to have enhanced experiences (Timothy, 2011). For instance, frontline heritage providers, e.g. curators and guides, are commonly mentioned as an enhancing factor by consumers. Thyne and Hede (2016) discovered that museum visitors require guidance to be co-productive, and their experiences were more fulfilling when an interpreter or curator assisted them. Similarly, in their exploration of heritage consumers' co-creating techniques, Minkiewicz et al. (2014) identified that consumers utilise intersections with staff at heritage settings to tailor experience to individual preference. Using technology and the assistance of employees, consumers select a semi-bespoke path through a heritage space based on their personal interests. A more recent and specific finding by Ross and Saxena (2019) addressing the importance of the provider role in co-creative heritage spaces explored the use of narrative storytelling to add content and texture at archaeological sites with limited viewable remnants. The research determined that providers' inputs through creative storytelling induced tourists to participate in co-creating experiences and narratives.

Perhaps one of the clearest explanations of the provider's role is Chronis' (2005, p. 7) framework of co-constructing the narrative experience at heritage sites. Referring to co-construction as 'consumers interacting with producers to mutually shape marketplace experiences', the study explored the construction and narration of stories at Gettysburg and identified that providers stage the narrative while consumers follow it. A key finding here was that narrative staging on the production side was needed to initiate the consumption experience and that this involved both substantive and communicative staging. The utilisation of tangible objects to stage an experience, such as landscapes, buildings, and museums, refers to substantive staging, while the interpretation of the environment and human-interest stories are considered as communicative staging. Due to the unique nature of each consumer of the heritage experience, interpretation

providers face the challenge of tailoring the storyscape based on the varied expectations of audiences. However, this customisation is, according to Chronis (2008), what leads to consumers contesting the story and ultimately contributing to a dialogue of co-creation. Creating such a dialogue of tourist experiences requires the creation and management of visitor-offering interactions, which Mathisen (2018) notes can be conducted by drawing on storytelling practices.

In a similar vein, Ross (2020) discovered the importance of allowing consumers to contest and contribute individual interpretations of heritage, avoiding the inflexible maintaining of an authorised discourse. The research also identified co-creation tools employed by heritage producers, including personalising experiences based on tourists' operant resources, presenting the site in a wider historical context, utilising primary evidence, encouraging free exploration of heritage, and emphasising active knowledge accumulation over instruction. These findings all demonstrate the presence and contributions of heritage producers as an essential aspect of consumers' co-created experiences. Hence, it is noted that staging the experiencescape where consumers of heritage settings are considered to be active actors leads to deeper experiences (Chronis, 2008, 2019).

Opportunities for such experience co-creation are known to be amplified with the inclusion of information and communication technologies (ICTs) (Neuhofer, 2016). However, Schmitt (2019) speculates that the rising relevance of newer technologies that 'incorporate digital information into solid, physical products' will uniquely impact experiences. Tscheu and Buhalis (2016) confirmed the significance of co-creation for AR in heritage settings in their research, formulating a value creation framework that provided an insightful overview of the process undertaken when developing AR. These findings also confirmed the existence and importance of co-creating the experience between the provider and the user of immersive technologies, a proposition conceptually reflected by Alimamy et al. (2018). However, as can be seen in Table 1, there is scope for this and future research to go further and to explore the potential of AR to inducing and refining experience co-creation.

Despite this gap, the idea that suppliers design an environment to support the consumer experience has been previously considered. For instance, Edvardsson et al. (2005) explored the use of hyperreality as a way to co-create value in servicescapes. Hyperreality, a term associated with Baudrillard (1994), is the notion of consumers' acceptance of simulations over the reality that they signify. This requires individuals to be immersed in an experience completely and vicariously, wherein they begin to undertake a role as part of the service experience. Edvardsson et al. (2005) researched hyperreality without technology, suggesting it be treated as a tool to create favourable, memorable, and realistic consumer experiences. Service providers can utilise signs and symbols to initiate such a hyperreal experience, as according to Venkatesh (1999, p. 155), visual semiotics are the new 'cultural order'. The use of hyperreality and immersion in this manner is reminiscent of what AR provides – a virtual environment wherein producers can place signs, symbols and artefacts to immerse a visitor and allow them to undertake a role in creating their own experience. In this research, we term this technology-based hyperreal environment as the 'virtually enhanced environment', referring to the fact that the environment that users are immersed in through AR is made up of both real-world and virtual assets.

To sum up this section and as demonstrated in Table 1, this paper strives to explore a gap in knowledge about the heritage producers' views of AR, with regard to experience co-creation. Hence, we first attempt to identify the producer-generated AR experience dimensions that are part of the virtually enhanced environment, and second, determine the techniques and mechanisms through which the dimensions are used to induce experience co-creation.

## Methodology

### Research settings

The research, utilising a qualitative approach, with an interpretive position in analysing the data, is centred around heritage settings in the United Kingdom (UK) which have developed AR applications specifically for use *in situ* at their site or museum. The varied forms of natural and man-made heritage sites, coupled with a wide tourism market (Visit Britain, 2020), and increasing institutional recognition of immersive technologies in the UK provides an appropriate setting for this research (Pittock, 2018). An overview of the 10 sites studied, and corresponding details about the AR, is presented in Table 2. These sites are located along disparate areas across the country and include tangible and intangible forms of heritage. However, all locations have an aspect of human intervention in the historical setting, with physical built heritage. Examples of two such sites are presented in Figures 1 and 2 – Uist Unearthed, depicting the virtual reconstruction of life-size round-houses, and Caerlaverock Castle, where a visitor is seen using the AR features of the application. Two sources of data are based around the same heritage setting, i.e. the Antonine Wall. Under the care of UNESCO World Heritage Sites (WHS), AR functionality for the Wall was developed by the WHS organisation, as well as by the Hunterian Museum. However, these projects do not overlap with each other, resulting in unique data collection from unconnected experts. The AR application developed for Fife Tourism includes content created for over 15 sites across the region of Fife; however, it has one lead participant. On initial analysis of these heritage settings and their corresponding AR experiences, it is recognised that there is no set pattern for how an AR experience is designed, which ensured that each participant had unique insights.

### Participants and recruitment

The study focuses on the supply side in the implementation of AR solutions in heritage. First, for reasons similar to those presented in Currie and Seltsikas (2001) work on application service providers (ASPs): the contextually under-researched nature of AR in heritage settings and the still emerging AR industry, with limited uptake of its solutions within the heritage sector. Second, this focus is informed by the fact that the role of heritage managers in shaping the heritage product, a key virtual outcome when considering AR, remains conceptually undeveloped (Farrelly et al., 2019).

This led us to adopt an expert interviewing approach on the supply side, drawing on the specialised knowledge of professionals in the field, an approach used in studies including Alexander et al. (2017) and Bec et al. (2021). Bogner et al. (2009, p. 54) define an expert as an individual who has 'technical, process and interpretive knowledge'

**Table 2.** Research settings overview.

| Heritage Setting | Background | AR Experience | Participant Pseudonym |
|---|---|---|---|
| Caerlaverock Castle, Dumfries, Scotland | Triangular castle built in the 13<sup>th</sup> century, now standing in ruins. Abandoned in the 1600s, the castle's history includes being besieged during the Wars of Scottish Independence, and later held by Clan Maxwell. | *Caerlaverock Castle Quest*: Targeted towards families with kids, the experience involves gamification, guiding visitors to various points around the castle grounds. Each spot has a virtual 'piece of flag' to be collected, while the visitors learn about the history of the grounds and the Castle, narrated by avatars of people who worked at the Castle. | Eric |
| Antonine Wall, Central Belt of Scotland | Built by the Romans around AD 140 as the northern most frontier of the Roman Empire, the Wall is now primarily lost, with specific sections still intact. | *Antonine Wall AR*: Visitors can view virtual versions of physicals artefacts at the spots where they were discovered. One location with visible ruins of the Wall can be reconstructed using AR in the application. Trivia regarding the Wall is shared, with the visitor having the option to read/listen to a short or detailed version. | Sally |
| National Waterways Museum, Liverpool, England | Museum built at the site of Ellesmere Canal, displaying the lives of people employed at the docks along with artefacts and vessels used. | *Window on the World*: Avatars of various people who worked and lived at the dock pop up at specific spots around the museum, narrating their daily lives and responsibilities at the docks. Visitors learn about the history from these avatars and can view boats in their original state virtually on the application. | Hannah |
| Hunterian Museum, Glasgow, Scotland | Based in the University of Glasgow, the museum covers a range of cultural topics, with the relevant one being the collections of Roman Scotland. Artefacts unearthed around the Antonine Wall are displayed. | *Views on Verecunda's Life - A Digital Window to the Scottish Roman Past*: Part of a wider project that involves virtual reality and 3D modelling, this section utilises AR exclusively. Visitors are introduced to the application and its story in groups. Verecunda, possibly a slave who worked around the Wall, is the historical figure the narrative runs around. Visitors are then provided with a device, which is fashioned to resemble a window discovered at the Wall. Artefacts that could have been part of Verecunda's life are then viewed through the AR application, where visitors can observe how they would have been used. The last stage of the experience encourages visitors to discuss with each other their reflections on Verecunda's life. | Jess |
| Hebridean Way, Outer Hebrides, Coast of Scotland | Route across 10 islands, with pit stops for visitors to explore nature, heritage and archaeological sites of the region. | *Uist Unearthed*: Contains various archaeological sites across the Hebridean Way that function as pit stops. Visitors can navigate using an inbuilt map, and view life-size reconstructions of prehistoric life. Includes content for younger audiences, as well as a narrated history of findings in detail. | Kate |

**Table 2.** (Continued).

| Heritage Setting | Background | AR Experience | Participant Pseudonym |
|---|---|---|---|
| The National Gallery, London, England | Art gallery founded in 1834, which holds a collection of work by Renaissance painter Paolo Veronese, with an AR R&D project focusing on one painting - *The Consecration of Saint Nicholas*. | *Virtual Veronese*: *The Consecration of Saint Nicholas* is viewed in its original setting in 156 at the San Benedetto al Po in Italy. Visitors can choose between narrations by the curator or by an avatar of an Abbot monk, who was a real historical figure. Visitors learn about the importance of commissioning such a painting during the 1500s. | Henry |
| Fife, Scotland | The region of Fife has historically been termed the Kingdom of Fife, which can be traced back to when the Pictish people resided there. This application takes visitors on a journey across key locations in the region, with unique AR content at spot. | *In the Footsteps of Kings*: Targeted towards families with kids, includes over 10 locations available on the application, that uses an avatar ('Jess the Jester') as a virtual guide for the users. There are no historical links between each location, and no story that is followed across the various spots. | Brooke |
| James Connolly Visitor Centre, Belfast, Northern Ireland | A visitor centre dedicated to James Connolly's life in Belfast, and located close to where the revolutionary stayed. Experiences include an interactive audio tour and AR heritage trail. | *James Connolly Augmented Reality Heritage Trail*: A heritage trail that guides visitors across Belfast, exploring 10 sites directly connected to James Connolly's life in the city. 3 experiences utilise in-depth AR, with reconstructions, while 7 are passive, information dissemination centred | Anne |
| Walls Alive, Derry | The Derry Walls completely surround the city of Derry/Londonderry. Built in the 17th century and still intact, visitors can walk the 1.5 km trail and stop by the centres located at the various gates. | *Walls Alive Derry*: A trail that directs visitors around the Walls surrounding the city, encouraging them to engage with sites not physically accessible. Aim of the app is to to urge visitors to enter visitor centres instead of isolated walks of the Wall. | Jack |
| Fraserburgh, Aberdeenshire, Scotland | A town in Scotland, with multiple historical sites rooted in its fishing tradition. | *Footsteps through Fraserburgh*: 20 sites around the harbour of the city, that passively present information and reconstructions. Various digital technologies included in the experience, with an aspect of AR. Digital content is primarily 3D scanned historical buildings, that can be viewed in the application. Scans and 3D models also accessible from website and remotely. | Zach |

relating to a specific field of action. Such expert knowledge consists of 'systematic, reflexively accessible knowledge of a specialised subject, along with character of practical or action knowledge' (Bogner et al., 2009, p. 100). In simpler terms, experts are informants who are specifically chosen because of their position within an organisation in the relevant field of action, and the corresponding experience and knowledge that their position may provide. Rarity of expertise or seniority of ideal interviewees can lead to issues with recruiting an extensive sample of participants (Otto & Österle, 2010). When

**Figure 1.** Uist Unearthed, Hebridean Way. Credit: Uist Virtual Archaeology Project



**Figure 2.** Caerlaverock Castle Quest. © Historic Environment Scotland

using experts as participants, it is preferred that interviewers engage in the interview without borrowing an extensive amount of the expert's time, and hence are required to prepare as much as possible about context, the setting and the expert themselves. Furthermore, expert interviews specifically help in exploratory research relating to fields that are not fully developed, allowing a rigorous collection of data from a smaller sample of informants (Littig, 2009).

In this research, we consider 'heritage producers' as experts, due to their responsibilities of managing a heritage setting, along with having previous experience of leading a team of stakeholders who have collaborated to successfully deploy (i.e. complete) an AR experience in a heritage setting. In the United Kingdom, immersive technologies have received institutional and governmental recognition and funding (Scarles et al., 2019). However, limited heritage settings have effectively developed immersive technology

experiences, resulting in scarce availability of experts for this research. The expected challenge of access to such experts was also faced in the process of recruiting informants, with 28 research settings approached, resulting in 10 acceptances to participate in interviews. The rarity of insights offered, due to the specialised roles of interviewees coupled with the novel nature of AR in heritage settings, we argue, offset this modest sample size (Bogner et al., 2009). Furthermore, interpretive research does not always expect generalisations from data, and recognises that reality may not be present to be discovered objectively (Pernecky & Jamal, 2010). The strength of such an approach lies in accepting that useful insights may be gained from a limited sample size, that the insights gained may stimulate ongoing research, and noting that assigning size parameters often leans towards a more positivistic approach (Boddy, 2016).

Participants for this research were selected based on their positions as decision-making actors in heritage organisations, and recruited through emails to 28 institutions. Approximately 16 of these responded to the research request, with 10 agreeing to participate in in-depth interviews lasting between 60 and 90 minutes. An interview guide was used, which explored key themes of the research, such as the process of developing each AR experience, in order to ascertain the reasoning behind decisions made regarding the contents of the experiencescape. The perspectives of the producers about their expectations of the visitors' involvement and participation when using AR were further discussed, which provided a segue into understanding the experience co-creation generating practices that were employed.

All interviews were tape recorded and transcribed, and reflection notes were maintained after each interview. We conducted thematic analysis of the qualitative data, which first included open coding when analysing the transcripts, followed by indexing data based on recurring themes across different data sources (Bryant & Charmaz, 2007). Data was then collated in Nvivo software, where we uncovered patterns by directing attention towards the frequency of thoughts shared by the experts, which then justified its categorisation as an emerging theme (Bell et al., 2018). The research goals of understanding heritage producers' approach towards utilising AR, and whether it could generate experience co-creation, directed this analysis that is presented in the following section.

## Findings and discussion

Insights from experts helped uncover the virtual and real-world elements that are commonly present as part of the 'virtually enhanced environment' for heritage settings. The virtual elements (historical reconstructions, avatars, virtual signage) need to complement the real-world elements (material enhancements, accompanying visitors), both operating in conjunction with each other to create an AR-driven experience for the visitors (Figure 3). It was further understood that these elements are included with the intention to generate experience co-creation, often through specific techniques: social interaction, personalisation, storytelling, gamification, and participation. The complete AR-driven experience is created to function as an interpretive medium, for visitors to understand the historical and societal impact of heritage settings (Oleksy & Wnuk, 2016), packaged in an interactive and engaging manner. The following sections outline and analyse these insights in detail.

Virtual Elements    Real World

## Virtually Enhanced Environment

Figure 3. Virtually enhanced environment.

### *Virtually enhanced environment*

The concept of the virtually enhanced environment refers to the experience space that is created when AR augments the physical world with virtual elements – in this sense, the real-world environment is *enhanced* through AR. It can be understood from the analysis that such enhancements made possible through AR were selected by the producers based on their overarching motivations for the experiences. For instance, Henry shared his views regarding Virtual Veronese - 'at the heart of the project was how to display the context for where this painting would have been made originally and where it would have previously been hung'. Based on this guiding factor, AR was identified as a relevant immersive technology, and furthermore, the virtually enhanced environment was accordingly curated.

Generally, it is understood that an AR experience is planned to begin the moment that visitors scan a physical marker, usually either placed around the heritage site or activated based on location, on an assigned device. Physical markers are not unique to heritage settings and are widely used across various sectors to trigger AR (Scholz & Smith, 2016). The formation of the virtually enhanced environment was realised as on initiation of the AR visitors are encouraged to interact with the virtual aspects, alongside external real-world factors, that align in order to present a complete AR experience. This existence of the enhanced environment is in conjunction with Edvardsson et al. (2005), who noted that a hyperreal service experience was created through co-creation prerequisite features available to consumers in the 'experience room'. The virtually enhanced environment in heritage is reminiscent of an experience room, with the key distinction that the elements in an AR experience are primarily virtual. The virtual and real-world elements identified from data collected as part of this study are presented next, and Table 3 presents an analysis of the elements of the virtually enhanced environments of each AR application studied.

### *Virtual elements*

#### *Historical reconstructions*

Reconstructing damaged or invisible heritage has been a fundamental element of creating more tangible experiences for visitors (Ross & Saxena, 2019). Reconstructions using immersive technology are increasingly common, with the visualisation of such heritage virtually being one of AR's unique features (Bec et al., 2019). For instance, regarding the virtual roundhouses in Uist Unearthed, Kate stated 'We've got a lot of lumps and bumps (of the roundhouse remnants) here, and we archaeologists know the sites but no one else does'. In this manner, AR was used to bring tangible presence to heritage assets with limited physical remains to work with, as was also corroborated by Brooke,

**Table 3.** Virtually enhanced environment – AR application analysis.

| | Virtual Elements | | | Real-World Elements | |
|---|---|---|---|---|---|
| | Avatars | Virtual Signage | Reconstructions | Material Enhancements | Accompanying Visitors |
| Caerlaverock Castle Quest | ✓ | ✓ | ✓ | | |
| Antonine Wall AR | | ✓ | ✓ | | |
| Window on the World, National Waterways Museum | ✓ | ✓ | | | |
| Views on Verecunda's Life, Hunterian Museum | ✓ | ✓ | ✓ | ✓ | ✓ |
| Uist Unearthed, Hebridean Way | ✓ | ✓ | ✓ | | ✓ |
| Virtual Veronese, The National Gallery, London | ✓ | ✓ | ✓ | | |
| In the Footsteps of Kings, Fife. | ✓ | ✓ | ✓ | | ✓ |
| James Connolly AR Heritage Trail | | ✓ | ✓ | | |
| Walls Alive, Derry | ✓ | ✓ | | | |
| Footsteps through Fraserburgh | | ✓ | | ✓ | |

> Historically in a ruin, you would have a tour guide explaining what you're looking at. We have got a 3D model of Lachore Castle, and there's very little left of it. You would need a human to really talk you through that space in the history of it, which now visitors can do themselves. So AR added value to what was already there and was not there.

This insight about the experience at Fife confirms the conceptual suggestion of this study regarding the heritage producer's central role as part of the heritage consumption experience. Furthermore, the suggestion that visitors can undertake this role of the service provider due to AR, by exploring the historical space themselves, alludes to the existence of experience co-creation in this context (Vargo & Lusch, 2017). Most experts related that reconstructing the heritage setting was the primary motivator for considering AR and that the experience was often built around these.

### Avatars

These virtual forms, often based around genuine historical figures or uniquely created characters, are used to 'guide' visitors around heritage sites. Kohler et al. (2011) referred to avatars in virtual worlds as the graphical representation users create of themselves, invoking a relatable feeling. However, heritage producers were found to utilise avatars in different capacities. The Derry Walls experience, for instance, utilised two avatars that had a conversation amongst themselves ' . . . to give a little bit of narrative interpretation and set the context for visitors' (Jack). Distinctly, another approach involved visitors being informed about the avatars that were constructed by the heritage producers, usually based on historical significance of the heritage setting. For instance, in the Virtual Veronese experience, visitors could exist in the experience alongside avatars,

> For the Abbot and Monk story you were told at the beginning of the story, 'You are a monk'. You were given a direct situation that you are a monk in this church and you're effectively listening into a conversation, but you're (actually) witnessing it. (Henry)

Other AR experiences leveraged on the entertaining features made available by avatars by engaging visitors in content that may have been unobtainable in a traditional experience. Brooke states, with regard to the Fife application:

> The avatar, Jess the Jester, talks you through the game and why it's happening. We've tried to make it fun, but it always goes back to heritage and the history of the place. Jess will impart historical facts at each site so whoever is engaging with it could hear and read there were other things happened here that they probably wouldn't care about otherwise

In contrast to the more passive use of avatars in Virtual Veronese, here it is noticed that the avatar of Jess the Jester is used in an interactive and enjoyable way by visitors, cementing the unique and flexible fashion in which AR can be used in heritage. Additionally, this empirically confirms Jung and Tom Dieck (2017) recommendation that AR can be used to create signature moments as part of visitors' experiences.

### Virtual signage

Information about settings that cannot be physically included at the site for a varying reasons is disseminated using AR. As related by Sally, AR allowed more detailed information about the Antonine Wall to be included ' . . . than you could put on interpretation panels, because obviously there is a limit to what you can put on them. And also, some people don't like those, they don't want to look at them'. Virtual signage allows information that could be of interest to a smaller segment of visitors with more direct interest in the site, alongside information that may appeal to a wider audience. Eric also notes the potential of virtual signage to preserve traditional interpretation panels that would otherwise be removed:

> The original cast metal plates . . . what we'd like to do is create virtual cast metal plates that would be AR triggered. You would be able to get multiple levels information from this – reconstructions just by tapping it, and almost just like appearing on wall.

It could be argued here that the interactivity provided by AR may overshadow the more passive use of virtual interpretation panels; however, as shared by Kate about sites across the South Uist island:

> Some people value a classic interpretation board, but they come with maintenance responsibilities. They get faded very quickly, and often the ones at Cladh Hallan are scratched down by cows . . . good information but just faded lying on the floor, not particularly engaging.

By retaining the traditional interpretation panels in virtual form, heritage producers are able to appeal to the set of visitors who might be interested in having information presented in a simplistic format. Furthermore, by replacing interpretation boards with virtual signage this, in addition, allows remote heritage settings to disseminate information with fewer concerns about maintenance.

### Real-world elements

### Material enhancement

Notably, a key finding from this research regarding designing AR is not directly related to the technology or virtual assets at all. Physical markers and devices (phones, tablets,

immersive glasses) are what give visitors access to AR (Javornik, 2016), and by fashioning these elements to reflect assets from the heritage setting, heritage producers created a physical connection to them. The Hunterian Museum enhanced the phones provided to visitors by placing them in a cover that is a mould of a window that was found at the Antonine Wall. As a result, the visitors were metaphorically looking into a window to the past when experiencing the AR. According to Jess,

> the experience uses this idea of a window, because we . . . have at the museum an amazing finding, which is a real window that comes from Bar Hill fort, one of the sites of the Wall, and it's got this little glass surviving and the metal frame around it . . . colleagues 3D printed this and we created covers to put on top of the mobile devices, imitating and alluding to the real window

This concept of customising material aspects that direct visitors to the AR experience was reflected by Kate regarding Uist Unearthed as well: 'There's a marker, a QR code, which is not a traditional QR code but based on our logo, three hills a round house with sort of jagged edges, which is what the phone picks up to launch the AR'. The use of AR, alongside other technologies of 3D printing and QR codes as previously described, was conceptualised by Jung and Tom Dieck (2017), who suggested methods to co-create value using emerging technologies. The insights from our research further demonstrate ways in which heritage tourism's foundational premises, such as the importance of an active visitor and utilising multisensory elements to engage visitors (He et al. (2018), can be maintained and transferred to new interpretive mediums. Furthermore, Jess notes - 'We wanted to give an idea of this challenge that when you're looking at the past, you never have the full picture. So . . . we use that as a metaphor, in our case this was the digital window'. This embodies the principle of heritage interpretation that the absolute, factual historical truth is out of the present's reach (Lowenthal, 1998), and confirms that this idea can be communicated in immersive technology applications through such device enhancement.

### *Accompanying visitors*

Heritage tourism literature has maintained that participation and engagement with surrounding visitors is an essential aspect of an engaging experience (Timothy, 2011). Heritage producers acknowledged the importance of this social aspect in experiences, and were keen on ensuring it is maintained even through AR. For instance, Jess shared:

> We wanted from the beginning for it to be a social experience, most visits in museums tend to be in groups. After all these years of digital applications of the tools, they often isolate us and we did not want that.

The importance of providing the opportunity for visitors to interact with one another was noted by Hannah who shared that looking back at the process, they would have made the National Waterways App more 'user friendly and social'. Through such insights, it is understood that allowing multiple visitors to exist in the same virtually enhanced environment space is a crucial real-world element.

### Experience co-creation techniques

One of the primary insights obtained through the exploration of the first research question (presented in the previous section), is that virtuality and augmentation offered by AR is utilised to form the virtually enhanced environment (Javornik, 2016). The collection of elements identified were found to be used in activities that can induce co-creation alongside visitors, as producers' motivation for using AR had less to do with the technology itself and more to do with how engaging it can make experiences. As put forth by Zach 'there are a lot of culturally significant sites around Fraserburgh that are unknown outside the local community, and the hope was that we would pull in visitors by utilising digital technologies'. The identified techniques constitute the producers' input in shaping AR co-created experiences and, essentially, refer to producers staging the experience, and assisting visitors with interpreting the heritage (Chronis, 2008, 2019). The mentioned techniques were also found to be frequently used to complement one another, with more than one opportunity for experience co-creation being adapted in a single AR application. Five techniques were uncovered through our research, which will be discussed in depth, supported with heritage producers' insights, next.

### Social interaction

This technique strongly relates to the real-world element of 'accompanying visitors'. Encouraging interaction among visitors, even when using the AR experience, was found to be an essential aspect of facilitating co-creation. The Verecunda experience at the Hunterian Museum was founded on ensuring that visitors had shared experiences by allocating space in between the experiences for visitors to interact:

> . . . there are two or three points where they (visitors) just talk to each other, and we found this . . . depends a lot on the dynamic of the group and the individuals. So, in some cases, if they had the time and interest, they wanted this last part to take longer. (Jess)

Literature has expressed concern about technologies isolating visitors from the physical presence of being in a heritage setting (King et al., 2016), however findings from this study showcase that AR can instead be used as a medium to facilitate group experiences. With regard to photos taken of the AR elements overlapping with the real world at Uist Unearthed, Kate reflects

> We had our MP visiting, so there's just this guy in a suit, next to a (virtual) bronze roundhouse. We've got a lovely picture of it, a little boy peeking through the door of the roundhouse. It's that kind of really nice contrast between the ancient and the modern.

Neuhofer et al. (2014) finding regarding consumer-to-consumer-based technologies leading to intense co-creation supports the contention that producers incorporating interaction with accompanying visitors, in the AR heritage context, could assist in collaborating in the co-creation of experiences. Alongside social interactions with other visitors, an additional central actor that heritage producers mentioned was the frontline service provider, such as the tour guide. Anne shared her thoughts regarding the James Connolly experience:

> I think as human beings, we want that interaction with another person. I think on this type of tour, even though you're paying for it, they still want to do it with the guide rather than doing

it themselves for free. People want that direction … and would still rather listen to the tour guide explain it to them, because they can ask questions of the tour guide.

The way that AR is designed negates the need for an individual guide and ensures that customised experiences can also be provided through a technological interpretation tool. However, Chronis' (2019) finding regarding guides at heritage sites composing and customising storytelling still holds true. The importance of the service provider in experience co-creation is known in literature (Ross & Saxena, 2019; Vargo & Lusch, 2017); however, a notable finding here is the confirmation that even during the use of engaging immersive technologies, heritage producers recognise the value of providing guidance for visitors when navigating historical spaces. Furthermore, this contrasts with Tom Dieck and Jung's (2017) observation regarding internal stakeholders not recognising the social value of AR experiences.

### Personalisation

Minkiewicz et al. (2014) relate that visitors attempt to navigate a museum space based on their interests, consulting guides, maps and technology along the way, and hence become a co-creator of their experience. Literature that has explored the organisation's role in co-creation has zoned in on the front-line employers, and their usefulness in adapting services based on individual needs – a notion that our research supported (Gwinner et al., 2005). However, heritage producers also attempted to make customising possible through immersive technologies, providing personalisation opportunities to visitors, primarily by creating content routes that allowed them to choose the type of content, storyline or chronology they want to follow (Pera, 2017). Furthermore, requirements of different types of visitors with varying levels of interest and knowledge of heritage settings was acknowledged, with AR providing the opportunity to curate differential levels of content to suit such segments. Henry and Kate shared their thought on this:

> Visitors were given the choice at the beginning to say which route would you prefer – curatorial route or the acted route. With the acted route, you were playing the role of a monk … so it really was trying to put the person in the experience as a character. With the curator journey, you're getting more of the descriptive thing. (Henry)

> There's different layers. You've got text, sort of a maximum of two sentences, and then you can choose to read more. Depending on how much you want … I think when you visit heritage sites or museums or art galleries, you're either the kind of person that looks at every single plaque, or you just want a brief overview. So you've got that opportunity. (Kate)

The insight from Kate regarding Uist Unearthed also reflects the use of virtual signage in giving visitors a level of control in personalising their experiences. Analysing these scenarios, it can be concluded that AR used for co-ordinating co-creation allows more than one type of content to be made available for visitors, who are assigned the role of a co-creator, by essentially asking them to choose and control their own experiences.

Regarding the National Waterways AR application, which included experience elements of avatars, reconstructions and virtual signage, Hannah reflected that they would probably approach the application differently on consideration 'We promoted it as "Meet the Character", but there was no engagement, or you couldn't personalise it or anything like that. Now we would include some custom things people can do with it'. This implies

the importance of incorporating AR strategically to ensure it actually engaged visitors, and avoiding a static or passive experience that visitors do not seem to be in favour of, reflecting the importance of appropriating enabling technology in consumer experiences (Breidbach et al., 2013).

### Storytelling

Prioritizing engagement and interaction in regard to AR, producers often preferred to avoid the passive and authorised discourse of a site, opting to be creative with the stories that they use. This theme was commonly noticed across insights from various participants and is substantiated by previous literature that recognised it as an effective way to involve visitors in experiences (Mathisen, 2018; Ross & Saxena, 2019). Thyne and Hede (2016) note the potential for visitors to form a connection with museums, when the offering is presented through expert storytelling. Stories have also been used by interpreters to inform visitors about heritage that may have been ruined and are not materially visible in the present (Ross & Saxena, 2019).

Adopting storytelling elements in the AR experience allowed producers to carry forward the creative nature of storytelling, in a digital manner, which consequently presented opportunities to develop narratives that were not possible in the passive sense. Jess shared: 'the reason we did storytelling is because we can see the quite dry, didactic curator label you find in museums . . . that kind of interpretation has been very traditional for many years'. Overcoming this docile experience in heritage settings, that fails to recognise visitors' expectations, has been an ongoing development in the literature (Timothy, 2011). This observation also reflects Chronis' (2008) findings regarding co-constructing a narrative by conducting communicative staging and gathering the interest of visitors through content adaption. Using experience elements of historical reconstruction, avatars and virtual signage, AR provides a way to allow visitors to get physically, and to an extent emotionally, involved in the heritage setting. Henry notes, regarding the experience at the The National Gallery where visitors could adopt the role of a monk: 'You were invited to kneel (in front of the painting) . . . and we did have a certain number of people that knelt in front of the painting and kind of were invited to sit and have that experience'. The immersive nature of AR here was found to transport visitors to a separate setting, allowing individuals to form a direct link between themselves and the storyline (Chronis, 2019).

### Gamification

Heritage producers shared that the manner in which visitors were induced to get involved in the storyline was occasionally through gamifying the experience. Gamification, which refers to using game design elements in non-game contexts, was primarily utilised in experiences that had younger audiences as the target (Leclercq et al., 2017),

> The heritage sites that children remember are the ones where they have fun . . . . You can fire a cannon at a pirate ship. You can build a castle that you can't see. These are all things that provide a bit of a wow factor. We wanted to take a cold site and bring it to life and that's the user experience. (Brooke)

When asked about utilising this approach for a mature audience, heritage producers were reluctant, due to concerns that it would encroach into pure gaming territory, leaving the

historical aspect behind. 'A child's experience of life is more simplistic to an adult . . . an adult could get involved in the battles and that sort of thing, but . . . If it's history, it would still need authenticity. You're walking into gaming then, aren't you?' (Brooke). This insight brings forth important questions about the influence that immersive technologies can have on authenticity, however alongside this, it is understood that the gamifying of an AR experience is based on separate priorities. For instance, Eric shares his thoughts about Caerlaverock Castle, and its game quest:

> We've pitched it as a kind of treasure hunt, with the idea that they would, they're gaining knowledge from us. As they go around one of the key things that we've got every one of the animations, apart from talking about their own role within the household, they also have a historical fact that they will give out to the visitor.

Utilising the virtual elements of avatars, alongside allowing visitors to explore the physical heritage space, the Caerlaverock Castle experience attempted to achieve a balance between the entertaining quest aspect and the learning experiences. Hence, it was discovered that although concerns of overly gamifying the experience were mentioned, AR allows various consequent experience co-creation opportunities, curated flexibly for different audiences.

### *Participation*

Experts delegated control of the experience and activities to visitors, requiring the latter to get involved and input their own operant resources. Brooke shared: 'They are responsible for a positive outcome, which is sinking the battleship or avoiding the animals. They are creating their own experience, because they need to practice and practice until they get it'. Ross and Saxena (2019) defined participative co-creation as the combination of activities from visitors and producers that allow a medium for understanding and making sense of the past. Such participation was induced by more than one type of AR experience studied as part of this research, along with showcasing the possibility of using AR to involve visitors in an emotional sense. The Veronese experience in fact attempted to, and succeeded, in eliciting physical action in reaction to the AR, by creating a strong religious story line that 'tells this new monk (the visitor) about the painting and really stressing the importance of the religious stories behind it, that's very powerful . . . and manifested itself in, did you kneel, or did you not kneel?' (Henry). This further confirms findings from Ross and Saxena (2019), surrounding the suggestions that participation can facilitate emotional connections, specifically when producer interpretive skills are leveraged.

The aforemetioned observations are reminiscent of the techniques of personalisation and gamification, suggesting that the different tools employed by heritage producers may complement each other. Successful experiences, according to Buonincontri et al. (2017), require direct intervention from tourists themselves, getting them involved in activities that allow the combining of basic practices of travel with more personal elements. This importance of personalisation is further supported by insights from experts, who encouraged visitors to question the information presented to them, and hence formulate unique perspectives:

> What was really important to us was this idea of multi-vocal understandings of the site and views of the site, because as archaeologists, obviously we've got fairly set ideas about . . . why

they did this, that and the other. But we wanted to give people an opportunity to say, well, what do you know? What do you think? (Kate)

An interesting observation with regard to the participation technique is its presence as an underpinning mechanism across the other techniques. Generally, participation is considered to have close links to co-creation, and this is noticed in the findings of this research. For instance, AR experiences that mobilised the gamification and social interaction tools required a deeper level of participation from the visitors than experiences that utilised storytelling or personalisation. The latter techniques were designed to function even when visitors choose to maintain minimal involvement.

## Conclusions and implications

Our research sought to first understand the process of conceiving AR for heritage settings, and then to explore how AR may be utilised to generate experience co-creation among visitors. The insights gained from heritage producers functioned as the foundation to introduce the 'virtually enhanced environment' that is created when AR is developed for heritage settings.

We identified the potential dimensions of experiences that producers utilise to induce experience co-creation through AR. This was addressed through a key contribution from this research, i.e. the conceptualisation of the virtually enhanced environment, which is composed of virtual and real-world elements. Previous research has informed the ingredients of AR in retail contexts (Scholz & Smith, 2016); however, these contexts assumed the agency of consumers in creating their experiences. It was clear from extant literature, supported by findings from our paper, that the heritage setting requires visitors' agency to be supported by producer guidance. As a result, the AR elements were found to be placed as directors, in the virtually enhanced environment. However, it was evidenced through the insights shared that the human factor was still required, often in the form of a curator or guide. Furthermore, using avatars, virtual signage, and reconstructions, producers placed the control of visitors' experiences into the hands of the visitors, while still ensuring guidance was present throughout if visitors required it.

With regard to the importance of using AR itself, our research uncovered that the primary unique feature that producers used to initiate experience co-creation was recognised to be augmentation (Javornik, 2016). This showcased that although the technology is beneficial for heritage, it is the content being portrayed through AR that was intended to be the primary source of facilitating co-creation. Producers valued focusing on what is being shown and disseminated through the virtually enhanced environment, more than ensuring that the technology and virtuality itself was perfect. However, this is contrasted by findings from previous studies that have uncovered that visitors value AR's visual appeal (Chung et al., 2015). We find this showcases a disconnect between visitors' requirements and the producers positions, and hence suggest the managerial recommendation to design the virtually enhanced environment based around visitor expectations.

The second question that our research aimed to address was regarding understanding whether and how heritage producers might be utilising AR to initiate experience co-creation. We found that heritage contexts require coordination for co-creating to occur (McColl-Kennedy & Cheung, 2018). This is often stimulated through the use of

complimentary co-creation techniques. The study conceptualised this coordination by identifying that producers utilise narrative staging by incorporating storytelling in AR, which is further assisted by gamifying aspects of the experiences. Experts were found to navigate towards utilising storytelling often, hinting at the way it allows an entire virtually enhanced environment to be built for visitors, even when minimal factual information is available. Other commonly occurring methods were those of providing visitors with options to customise aspects that are relevant to them (personalisation), encouraging participation with the AR content and the heritage site, as well as ensuring that interactions among visitors occurred. Furthermore, AR applications that did not incorporate elements that could facilitate experience co-creation were found to create passive experiences, which experts advised were a drawback and a failure in appropriately utilising the technology.

Hence, from a managerial implications perspective, this research offers directions regarding leveraging the opportunities that AR provides for heritage settings. Heritage producers should focus on applying the right strategies when designing experiences, which should be supplemented with elements of AR experience. Attempting to create perfect virtual aspects in AR, without ensuring that visitors contribute certain resources, could lead to a less engaged and passive visitor. Furthermore, by providing visitors with a space to input their own operant and operand resources, heritage settings can attain a balance between allowing visitors to be active, as well as retain the authorised heritage discourse.

This research was conducted specifically in the heritage sector, however it can be suggested that the designing of AR and the virtually enhanced environment to facilitate experience co-creation might be similar in other contexts. Hence, we bring forth an opportunity for further research to recognise the manner in which organisations in other service sectors design and strategize AR experiences. Utilising a smaller sample in this study allowed the research to examine deep insights, however future studies could also attempt to conclude generalisability by expanding the sample and studying a wider range of participants. Insights from experts showcased the use of gaining information from the community to create AR content, a finding that has not been noticed in extant research. Such practices of crowdsourcing content for heritage challenges notions of the authorised heritage discourses as well as authenticity, and offers the possibility of uncovering a unique phenomenon that we recommend should be examined further.

## Disclosure statement

## Funding

## Notes on contributors

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