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Research Paper: **Augmented Reality, Virtual Reality and 3D Printing for the Co-Creation of Value for the Visitor Experience at Cultural Heritage Places**

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Augmented Reality, Virtual Reality and 3D Printing for the Co-Creation of Value for the Visitor Experience at Cultural Heritage Places

Abstract

Purpose

This paper aims to propose a value co-creation framework through examining the opportunities of implementing augmented reality, virtual reality and 3D printing in to the visitor experience in the cultural heritage places.

Design/methodology/approach

This study proposes the conceptual model of value co-creation using a case study approach by presenting some cases of a cultural heritage place in UK.

Findings

Findings suggest that the effective use of multiple technologies in the context of cultural heritage places contributes to the co-creation of value for both cultural heritage organisations and also for visitors' pre-visit, onsite and post-visit experience. Businesses can benefit from increased spending, intention to return and positive word-of-mouth while visitors receive a personalised, educational, memorable and interactive experience.

Practical implications

Cultural heritage places have to find new ways to in order to survive increasingly fierce competition. Using technology and the concept of value co-creation can prove to be a valuable concept in an attempt to attract new target markets, enhance visitors' experience, create positive word-of-mouth and revisit intentions.

Originality/value

Recently, increased importance has been placed on the co-creation of value to account for consumers interest in playing part in the development of services and products recently. This research takes a holistic approach using augmented reality, virtual reality and 3D printing from value co-creation perspective.

Key Words Augmented reality, Virtual reality, 3D printing, Value co-creation, Visitor experience, Cultural heritage places

Introduction

The increased availability and penetration of technology has impacted the way places market and promote their heritage destinations (Minazzi, 2015). In particular, there has been an increased importance on value co-creation as a result of social media advancements, with customers expecting to play a role in the service and product creation process. Latest technological advancements such as augmented and virtual reality have further impacted the way people experience their surroundings (Jung *et al.*, 2015; Jung *et al.*, 2016). Research on augmented and virtual reality in the context of cultural heritage has picked up over the past 3 years with a number of studies recognising the opportunities of personalised experiences and tours (tom Dieck *et al.*, 2016) or sustainable tourism growth (Cranmer *et al.*, 2016).

A particularly interesting development has been with regards to 3D printing as numerous new use cases have emerged over the last years (Groenendyk and Gallant, 2013). The gaming industry, medical industry and food industry (e.g. the printing of 3D chocolates) are just some examples of lucrative 3D printing applications (Kelion, 2014). Clarke *et al.* (2014) revealed that 3D printing is still at an early innovators stage with another 15-20 years until the technology is more feasible to use for the daily consumer market. Nevertheless, there are already some examples of supermarkets experimenting with 3D printing such as ASDA which tested the idea of “Create amazing mini me”, which is a replication of a person that can be printed out as a gift (Create amazing mini me, 2013).

Recently, increased importance has been placed on the co-creation of value to account for consumers increased interest in playing a part in the development of services and products (Pralhad and Ramaswamy, 2013; Saarijärvi *et al.*, 2013; Yi and Gong, 2013). Nevertheless, according to Kristensson *et al.* (2008, p. 475), “there is a paucity of research on the theory and practice of user involvement (as one form of co-creation) during both new product and service development... [and] a lack of a firm theoretical foundation on which to base an understanding of the strategies which are required for success during the co-creation of services”. Furthermore, when it comes to the implementation of the latest technologies it is important to consider perceived value from the consumers’ point-of-view to ensure high acceptance rates and intention to use (Kristensen *et al.*, 2008). There have been many attempts to use augmented reality and virtual reality to enhance visitor experience and interpretation of cultural heritages (Han *et al.*, 2014). In addition, 3D printing has been used within museums and art galleries to create objects of different exhibits (Hess and Robson, 2013), replicate objects (Klein *et al.*, 2014) and to study, educate and preserve (Neumüller *et al.*, 2014). However, no attempts have been made to introduce a combination of augmented reality, virtual reality and 3D printing into visitors’ experiences from the perspective of value co-creation. Thus, this paper aims to propose a value co-creation framework through examining the opportunities of implementing augmented and virtual reality as well as 3D printing into the visitor experience of cultural heritage places.

Literature Review

Co-Creation of Value

Traditionally, the creation of value used to be a one-way street where only firms created and provided customer value (Clarke *et al.*, 2014). Changes in behaviour and expectations created new dynamics and therefore, industry moved towards the co-creation of value whereby businesses and customers play an equally important role in ensuring that value is created (Clarke *et al.*, 2014; Prahalad and Ramaswamy, 2013; Saarijärvi *et al.*, 2013). This new approach is associated with service-dominant logic (S-D logic) and strengthens the importance of the consumer in the value co-creation process (Prebensen, 2013; Yi

and Gong, 2013). Prior to the S-D logic, the goods-dominant logic (G-D logic) used to be the norm which mostly focused on the exchange of resources. On the contrary, the S-D logic involves the inclusion of consumer knowledge and skills (Vargo *et al.*, 2008).

The general idea of value co-creation comes from the belief that consumers should play a vital role in the innovation process of new services and products to make sure that value is added from their point-of-view (Zine *et al.*, 2014). Thus, consumers take an active role in the development process which is expected to add value to the overall experience (Kristensen *et al.*, 2008). Grönroos and Voima (2013) explored the co-creation process and revealed a model that focused on the different spheres within a service or product delivery and consumption process. According to their model, there are three different spheres including the provider sphere, customer sphere and joint sphere. The interaction between customer and provider are either indirect or direct and value can only be co-created if direct interaction is taking place (Minkiewicz *et al.*, 2014). There are several examples how customers can be involved in the co-creation process, from the IKEA business model whereby customers pick-up, transport and assembly products, to theme parks such as Walt Disney where experiences are staged with visitors' and employees' involvement (Payne *et al.*, 2008). Also within the place branding literature, the co-creation of value was identified to "lead to increased ownership of the brand and therefore more sense of responsibility for its development, management and external reputation" (Braun *et al.*, 2013, p. 23). Furthermore, this approach was identified to enhance successful implementation of new products and service while at the same time helping companies to create a sustainable competitive advantage (Kristensson *et al.*, 2004). According to Prahalad and Ramaswamy (2013, p. 33), value is added "where individuals exercise choice". Ranjan and Read (2014, p. 293) revealed that the form of customer participation may vary within the co-creation framework as it might be "evidenced in a facilitation role at the periphery of a firm's processes, or in an active role through the application of knowledge and sharing of information with the firm".

Within the cultural heritage places domain, scholars confirmed the importance of letting consumers take part in the process of value co-creation to create "rich and memorable experiences" (Binkhorst, 2006; Neuhofer *et al.*, 2012, p. 36; Prebensen, 2013). In addition, Binkhorst (2006, p. 4) revealed "when the experience environment is sufficiently compelling, customer communities can take on a life on their own and thereby becoming directly involved in the co-creation of individual experience". Especially in cultural heritage places, Prebensen (2013) revealed that tourists want to play an active role in creating memorable experiences. Overall, moving tourists and visitors from passive receivers of experience to active participants and co-creators is expected to create sustainable competitive advantages (Payne *et al.*, 2008).

Minkiewicz *et al.* (2014) conducted a study in the cultural heritage sector and aimed to explore how consumers benefit from the co-creation of value as part of their experience. They found that "consumers actively co-create their consumption experiences through co-production, personalisation, and engagement" (Minkiewicz *et al.*, 2014, p. 46). Cultural heritage places can facilitate this co-production, engagement and personalisation through the provision of thought-out experience spaces. Nevertheless, engagement was found to be much more than simply staging of experiences as suggested in the "*experience economy*" by Pine and Gilmore (1999). Instead, Minkiewicz *et al.* (2014) suggested a full cognitive and emotional immersion in the experience as part of the value co-creation process.

Some of the scholars who extensively researched in the field of value co-creation are Saarijärvi *et al.* (2013) who presented the value co-creation process shown in Figure 1. Saarijärvi *et al.* (2013, p. 12) raised the questions “what kind of value is co-created for whom, by what resources, and through what mechanism?”. According to Saarijärvi *et al.* (2013), these questions should be asked by every organisation that considers itself innovative or aims to become an innovative business. As revealed by Zine *et al.* (2014, p. 33) “customers today are more knowledgeable, informed and connected due to information communication technologies. They are more demanding and seemed unsatisfied, they want things to happen their way, and not the way the providers are offering. Customers are increasingly looking for opportunities to create value for themselves along with the firms/providers”. Therefore, considering the different constructs within value co-creation model is deemed essential in order to stay on the bandwagon and create sustainable business operations within the cultural heritage sector.

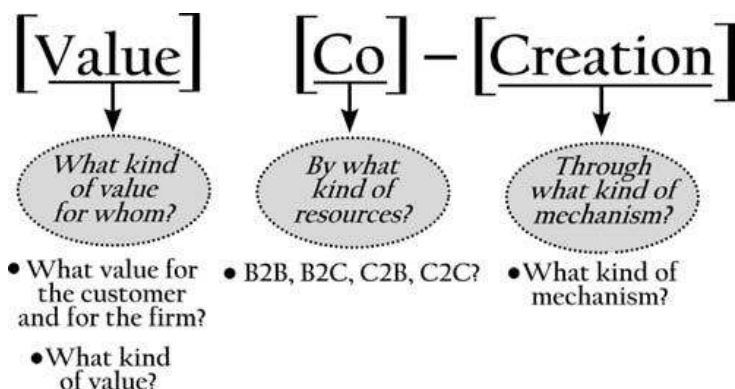


Fig. 1. Value Co-Creation (Source: Saarijärvi *et al.*, 2013)

Augmented and Virtual Reality at Cultural Heritage Places

Technology has had huge impact on the management and marketing of places. Particularly within the cultural heritage context, recent research explored the opportunity of integrating cutting-edge technologies such as augmented and virtual reality for the enhancement of the tourist experience (Jung *et al.*, 2016; tom Dieck and Jung, 2015). The increased importance of creative industries has led to an even stronger focus on the potential of new technologies within the cultural heritage sector. Therefore, cultural heritage places are increasingly looking for new ways of creating and enhancing the experience of their customers (Bakshi & Throsby, 2012). According to Sundaram (2014, p. 74), “progress in information technology has provided us with the opportunity to improve both the quantity and personalisation of cultural information”. Recently, augmented and virtual reality were found as ideal technologies to provide visitors with enhanced, personalised and enjoyable information (Han *et al.*, 2014; Leue *et al.*, 2015). Augmented reality is the overlay of digital information into users’ direct environment through a hand-held, wearable or small device (Rauschnabel *et al.*, 2015; tom Dieck and Jung, 2015). However, tom Dieck *et al.* (2016) and Tussyadiah (2014) developed this further and explored the potential of smart glasses for cultural heritage sites which offer visitors the opportunity to access information in a hand-free and un-cumbersome approach. In contrast, virtual reality, which is a fully immersive experience whereby a digital world is created to portray a different experience. Virtual museums have been created in order to allow people to overcome physical constraints and provide public access to art and culture (Hung, Chen, Hung, & Ho, 2013). However, from the supply side perspective, there are several negative effects such as limited spending and personal interaction (Hung

et al., 2013). More recently, it was therefore explored how virtual reality could be a viable part of the on-site cultural heritage experience to overcome the barriers of not physically visiting the museum. Interestingly, virtual reality can be used to explore hidden gems of museums as well as access sites that are normally non-accessible (Jung *et al.*, 2016). Sportun (2014, p. 338) agreed that augmented reality “can place [objects] in historical context [and] can enhance museum displays by explaining the use and significance of objects”. As a result, cultural heritage sites should make use of latest technological development of both augmented reality and virtual reality in order to capitalise the opportunities to increase income, visitor engagement and intentions to return (Han *et al.*, 2014).

3D Printing

3D printing has experienced increased interest for the consumer market due to enhanced capabilities and decreased costs (Moilanen *et al.*, 2014). These opportunities arise due to enhanced precisions, finer resolutions and higher printing speeds (Cohen *et al.*, 2014). 3D printing allows consumers to replicate existing objects in a three dimensional manner in various materials depending on the 3D printer used (Klein *et al.*, 2014). For the consumer market, there are several websites such as Thingiverse or 3D Creation Lab which allow users to order personalised 3D objects. However, so far these companies cover, both, the design and manufacturing process (Klein *et al.*, 2014). Groenendyk and Gallant (2013) investigated opportunities of 3D printing at the Dalhousie University Library and found that the biggest challenge laid in ensuring that students had the necessary skills to design an object and print it. Thus, limited user experience is drawback of using 3D printing; and therefore businesses have to facilitate the process by providing pre-developed existing models. Then, these models simply can be selected to be printed without model development required by the customer. While in the past, 3D printing used plastic, modelling clay, silicone, plaster or metal to name a few (Walters and Davies, 2010), recent developments allow the production of chocolate 3D printing which is an interesting advancement for the visitor economy. Companies developed applications to facilitate the process of printing out personalised sweet treats (Kelion, 2014). These new developments show how technology is used to enhance consumer goods and how quickly 3D printing is evolving and can be used in various different industries to enhance consumer experience. According to Walters and Davies (2010), there are more researches that explore the opportunities of 3D printing in art and design with particular focus on the creation of exhibits using 3D printing. As far back as 2005, Allard *et al.* (2005) experimented with the replication of human skeletons using hand-held laser scanners and 3D printing for a museum exhibit with the ultimate goal of enhancing visitor experience. They revealed that 3D printing is particularly interesting due to low costs in replicating objects in the context of museums (Allard *et al.*, 2005).

Case Study: Geevor Tin Mine Museum

Geevor Tin Mine Museum is a UNESCO World heritage site and cultural mining heritage attraction in Cornwall. It is an old tin and copper mine from the 18th century and has been preserved as the largest such mining site in the UK. The museum’s target market is varied and encompasses school groups, families and elderly visitors, however, parts of the museum are difficult to access (e.g. underground mines). In order to provide engaging experience for its target markets, Geevor Tin Mine museum started to explore the use of multiple technologies, including augmented reality, virtual reality and 3D printing in 2015 (see Figure 2). At Geevor Tin Mine museum, the mobile augmented reality application was designed in order to enhance visitor experience and also support the tour guides during busy periods. A miner’s avatar was designed in order to guide visitors around the museum. The virtual reality application was used for the pre-visit stage as well as on-site underground mining experience. Certain elements simply provided a digital model of existing rooms and mines, while another

animation allowed visitors to enter a mine through a mine shaft that is normally inaccessible. Finally, as can be seen in Figure 2, there is the opportunity to print a small 3D miner souvenir. This could be changed in colour or printed with a name tag in order to provide a personalised souvenir based on visitors' physical and virtual experience through augmented reality and virtual reality applications.



a. AR Experience



b. VR Experience



c. 3D Miner Souvenir

Figure 2. Geevor Tin Mine Museum Multi-Technology Approach

Opportunities of Technologies for Value Co-Creation in Cultural Heritage Places

Based on current technological advancements in terms of augmented & virtual reality and 3D printing and the estimated increased importance of these for cultural heritage places, we propose the idea of implementing multiple technologies into the direct visitor experience within cultural heritage places as shown in Figure 3. The concept of co-creation is considered extremely important within the visitor economy (Kristensson *et al.*, 2004). To propose the value co-creation framework within the cultural heritage context, we adopted the work of Saarijärvi *et al.* (2013) to fit the context of multiple technologies. The idea can be separated into pre, during and post visitor experience.

With regards to the pre-experience, cultural heritage organisations could provide their visitors with virtual reality applications prior to the visit to introduce sites and thus, enhance intention to visit. During the visit, augmented reality applications could be used to enhance the experience through overlaid information. This could enhance the hedonic experience and also the learning experience (Leue *et al.*, 2015). In addition, virtual reality applications could be utilised for interpretation of hidden cultural objects and also enhancement of visitor experience at cultural heritage places especially from the perspective of accessible tourism. This has been successfully tested by Jung *et al.* (2017) who found that senior visitors at Geevor Tin Mine museum accepted and enjoyed visiting part of the museum using virtual reality. Finally, it is proposed that the same application could be used to facilitate the production of 3D souvenirs based on viewed objects, 3D printed after the experience. This could enable visitors to have an enjoyable and interactive experience and being provided with a personalised gift or souvenir after the experience. An example of such a personalised 3D gift at Geevor Tin Mine Museum is shown in Figure 2. Taking into account previous findings from Minkiewicz *et al.* (2014), this approach could add value to visitors' social and hedonic experience. Furthermore, using multiple technologies for the entire visit could create a rich, enjoyable and memorable experiences (Binkhorst, 2006; Neuhofer *et al.*, 2012, Prebensen, 2013).

From a heritage management point of view, the provision of this service can increase the visitor spending, provide visitor insights, attract new target markets and increase the intention to revisit. Particularly the creation of a personalised souvenir could potentially lead to word-of-mouth and the attraction of a new target market. This concurs with research by Prahalad and Ramaswamy (2013) who revealed that value is added when customers are able to exercise choice. Providing visitors with personalised virtual and augmented reality experiences can therefore be considered an important part of the value co-creation process. With regards to the creation of 3D souvenirs, Pine and Gilmore (2011) and Minkiewicz *et al.* (2014) confirmed the importance of creating memorabilia to create a signature moment of the experience. In addition, Neuhofer *et al.* (2014, p. 347) identified that co-creation leads to social connectedness as “sharing is a central premise to the social experience”. Using an augmented reality application that allows the sharing of content with the wider social media network could be an important part of a museum and art gallery visit. In addition, it allows visitors to create their own 3D souvenirs, and share them with families and friends (Neuhofer *et al.*, 2014). Minkiewicz *et al.* (2014) confirmed the importance of personalisation as part of the value co-creation process in cultural heritage places, and modern 3D printing allows for the creation of personalised souvenirs (e.g. adding names, colours etc.). This adds another dimension of personalisation to the experience within museums and art galleries.

Further, Bakshy and Throsby (2012, p. 206) revealed that “since many creative products are easy to reproduce, store and transmit through digital means, digitisation has created unprecedented uncertainties for many creative enterprises, making it imperative that they find ways to reinvent their business models to capitalise on the opportunities and avoid the threats that the new environment brings”. Cultural heritage places should capitalise on opportunities mobile and wearable devices bring for augmented and virtual reality as well as consider trends such as 3D printing for future operations.

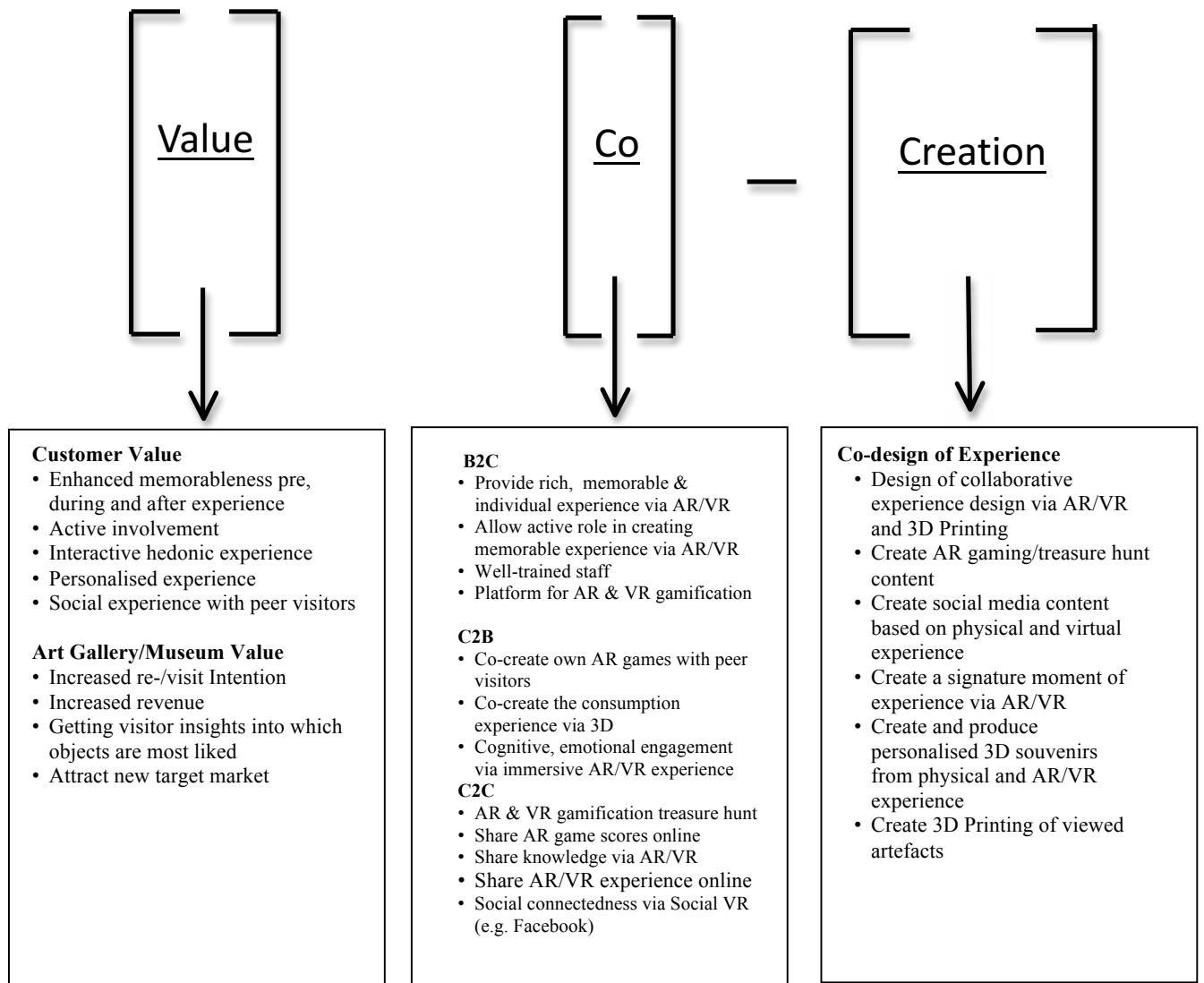


Fig. 3. Value Co-Creation in Cultural Heritage Places through Augmented reality, Virtual reality and 3D printing

Clarke *et al.* (2014, p. 3) revealed that a “key problem ... arises [when] the consumer may lack the knowledge or training to successfully design a product...One possible response to this dilemma is to offer collaborative design services, whereby a suitable professional works with the consumer to design the object and materials specification, which the consumer can then fabricate themselves”. Thus, it is crucial for cultural heritage places to utilise easy to use applications for the enhancement of the visitor experience. In particular, it is important that cultural heritage places make it a seamless and enjoyable process to ensure satisfaction and revisit intentions. As shown in the framework, staff training is considered key to facilitate a smooth running of the experience as staff are normally first point of contacts with regards to questions. This concurs with a previous study by Khanagha *et al.* (2015) who found that senior management of organisations that engage in new technology co-creation activities has to place substantial human but also financial resources on these activities in order to ensure a smooth and seamless operation. The visitor would play a crucial part in the co-creation process, as they would

provide the creative elements, sharing content as well as creating their own personalised souvenirs to take home. Ranjan and Read (2014) revealed that knowledge sharing is among the most important aspects of the co-creation of value as it builds competences in the process and thus, adds value.

Augmented and virtual reality applications and 3D printing facilities can be considered ideal technologies for collaborative design as content can be regularly updated based on feedback, visitor insights, likes and dislikes (Saarijärvi *et al.*, 2013). In particular, augmented reality allows for the inclusion of visitors' own content into the application (e.g. audio, recorded by visitors, based on their interpretation or recommendations, could be overlaid onto museum objects to create social connectedness). This idea of recording videos for new visitors to see has been implemented by museums such as the Museum of Science and Industry in Manchester. New technologies allow for a new form of interpretation among a wider network and augmented reality can be seen as one form of displaying this information. Gamification emerged as another area within the tourism domain and cultural heritage places started to implement the idea of augmented reality gamification into their experience (Bulencea and Egger, 2015; tom Dieck and Jung, 2016). As a next step, visitors could create their own treasure hunts within museums to be solved by fellow visitors. This idea shows how augmented reality content could be co-created by visitors and cultural heritage places. In addition, the idea of sharing scores online has long been implemented within the gaming industry and using a similar approach within cultural heritage places could add to the co-creation of value (B2C & C2C) as it promotes the cultural heritage place, triggers visitors to return to solve new problems as well as attract new markets. Nevertheless, visitors will be the ones either accepting or rejecting this new application thus, it is crucial to take their opinions into account as early as possible for the co-creation of value (Zine *et al.*, 2014).

Overall, it is suggested that cultural heritage places create easy to use augmented reality and virtual reality applications (Clarke *et al.*, 2014), that incorporate the enhancement of objects and artefacts through digital content, (fully immersed virtual or overlaid augmented content). Furthermore, it is suggested to provide an opportunity to select favourite objects to personalise and 3D print them as a souvenir after the experience. This is expected to help cultural heritage places to benefit from increased spending power, stronger revisit intentions and new target markets. In addition, the use of applications provides cultural heritage places with big data which can be evaluated for visitor insights. Finally, visitors are expected to have a personalised and unique experience (Saarijärvi *et al.*, 2013). The importance of personalisation as part of the co-creation process was supported by Ranjan and Read (2014, p. 294) who revealed "personalization results in possibilities of cultural reshaping and reinforcement through the uniqueness of the process", this in turn leads to enhanced experiences and competitive advantages.

Overall, it is important to emphasise also the benefits from a visitor's point-of-view when it comes to the co-creation of value through technologies as discussed in our theoretical model. It can be concluded that intangible experiences through the real experience as well as augmented and virtual reality, can be made tangible through the use of 3D printing and the creation of personalised souvenirs. This can create memories, which benefits visitors to reflect on their experience. In addition, augmented and virtual reality does not necessarily need to be limited to the on-site and pre-experience, but visitors could save information and revisit the museum while being at home. This creates the educational element which is considered immensely important for cultural heritage places (Leue *et al.*, 2015).

Nevertheless, as part of this discussion it is important to also focus on current drawbacks of the proposed model. The development of augmented and virtual reality content, provision of devices and purchase of 3D printers requires a considerable amount of investment. However, with technology advances, these costs are expected to decrease (Nichols, 2016). Already today, with widespread use of smartphones, cultural heritage places can offer basic applications for visitors' own devices thus, create an interactive experience using only small investments. However, a study by Cranmer et al. (2016) found one of the barriers is assuming that everyone has a suitable device, especially the older target market. Google cardboard furthermore offers an inexpensive opportunity to provide virtual content (Fabola et al., 2015). With the progression of time, more advanced applications and devices can be offered. With regards to 3D printing, as mentioned above, it is a very time consuming and expensive process however, new developments are expected to bring these costs down (Abrams, 2015). Therefore, the current paper should be seen as a theoretical framework for future technology integration. In addition, as shown by a number of studies, technology progresses quickly and the proposed idea of implementing augmented and virtual reality as well as 3D printing should not be seen as exhaustive. New technologies may emerge and add another layer of co-creation to the proposed model.

Conclusion

This study aimed to propose a value co-creation framework through for the incorporation of augmented reality and virtual reality applications as well as 3D printing in cultural heritage places. Saarijärvi *et al.*'s (2013) conceptual model was used as a theoretical foundation for the co-creation of value between B2C, C2B and C2C. Previous studies (Han *et al.*, 2014; tom Dieck and Jung, 2015) identified that the integration of new technologies such as augmented reality, virtual reality and 3D printing can be considered a key for cultural heritage places to stay competitive. Thus, tourism businesses and cultural heritage organisations in particular are recommended to utilise technologies such as augmented reality, virtual reality and 3D printing to enhance the visitor experience.

Theoretically, using a case study approach, this study proposes a value co-creation framework from the perspective of a multi-technology approach using augmented, virtual reality and 3D printing, for the cultural heritage context. In particular, the proposed framework shows that the effective use of multiple technologies in the context of cultural heritage places contributes to the co-creation of value for both cultural heritage organisations and also for visitors' pre-visit, onsite and post-visit experience. Further, the potential of these multiple technologies for joint value development between cultural heritage organisations and visitors, as well as value sharing among visitors from the place management perspective, is demonstrated. The proposed framework signifies the start of a new area of practice and research, the purpose of which will be to inform the realisation of this proposed scenario within cultural heritage places.

As a first step, virtual reality is expected to provide visitors with a first glance of the museum and hence, entice them to visit physically. Secondly, augmented reality has been identified as an ideal technology to provide enhanced information thus, add value to the experience, allow visitors to share their experience as well as leading to the intention to spend money. At the same time, augmented reality applications should enable visitors to directly link their experience to the creation of a personalised souvenir, potentially 3D printed. This is proposed to be an important part of the value co-creation process as it adds a sense of being part in the production of the experience (Ranjan and Read, 2014). According to Huang *et al.* (2013), particularly with the increased availability of virtual tourism,

businesses have to think about ways to attract visitors directly into cultural heritage places. Nevertheless, previous research by Groenendyk and Gallant (2013) revealed the difficulties in terms of knowledge and skills associated with augmented and virtual reality and also 3D printing and therefore, a thorough development of an application that facilitates the use of augmented and virtual reality as well as 3D printing is considered important to ensure successful implementations for this new visitor experience at cultural heritage places.

This study conceptualised the idea of using augmented reality, virtual reality and 3D printing within cultural heritage places to create an environment of value co-creation as part of the experience. This is expected to increase competitiveness of cultural heritage places as well as enhance the connectedness among visitors, an important part of today's social experiences. Further research is required to qualitatively explore the idea of value co-creation through augmented and virtual reality and 3D printing in the cultural heritage context. Therefore, it is suggested to conduct focus groups with a wide range of stakeholder to explore the full potential. Finally, according to Nenonen and Storbacka (2010, p. 43), "a firm can radically improve the value co-creation by designing business models that have high degree of internal and external configurational fit" and therefore, future research is recommended to explore a suitable business model for the investment and implementation of multiple technologies into cultural heritage places.

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