

The Impact of Mixed Reality on Visitors' Experience in Museum. 'The Ara As It Was' Project in Rome



Mariapina Trunfio, Salvatore Campana and Adele Magnelli

Abstract Although new realities are receiving increasing attention in tourism, the effect of them on cultural heritage has still not been fully answered and research on this topic is still in its infancy. This paper aims to contribute to advances in research on visitors' experience analysis in museums, applying the Trunfio and Campana (Curr Issues Tourism 1–6, 2019) model for mixed reality in museums. The empirical analysis concerns 'The Ara As It Was', a mixed reality project installed in the iconic and historical Ara Pacis Museum in Rome (Italy). The findings, discussion and conclusion open new avenues of research and suggest managerial implications to improve museum competitiveness.

Keywords Mixed reality · Museum · Visitors' experience model · Visitors' satisfaction

1 Introduction

Cultural heritage organisations, including museums, are exploiting new reality opportunities to redesign their service models, creating an immersive site-visit and combining diverse experience typologies (Trunfio & Campana, 2019). Augmented and Virtual realities have transformed heritage museum in a smart place where drawn virtual maps, digital simulation and immersion, appealing graphics and audios, facilitate enjoyment and emotional fruition, reducing traditional barriers and enhancing information for non-expert visitors (tom Dieck & Jung, 2017). In this perspective, many museum are investing in new technologies with the main goals of enhancing

M. Trunfio (✉) · S. Campana

Department of Management and Quantitative Studies, University of Naples "Parthenope", Naples, Italy

e-mail: trunfio@uniparthenope.it

S. Campana

e-mail: salvatore.campana@uniparthenope.it

A. Magnelli

ETT Spa, Genoa, Italy

e-mail: adele.magnelli@ettsolutions.com

© Springer Nature Switzerland AG 2020

T. Jung et al. (eds.), *Augmented Reality and Virtual Reality*, Progress in IS,
https://doi.org/10.1007/978-3-030-37869-1_25

the value of visitors' virtual experience (Fenu & Pittarello, 2018; Han et al., 2018; tom Dieck & Jung, 2017).

Although new realities are receiving increasing attention in tourism research and cultural heritage (Guttentag, 2010; He et al., 2018; Jung et al., 2018; tom Dieck & Jung, 2017; Yung & Khoo-Lattimore, 2019), the impact of them on cultural heritage have yet to be fully answered and research on this topic is still in its infancy.

In a recent study, Han, tom Dieck, and Jung (2018) identified an user experience model, evaluating augmented reality applications in urban heritage tourism in terms of content, presentation, functionality and interaction. Building on the prevalent literature and Han et al.'s, model (2018), Trunfio and Campana (2019) propose a novel model that captures the impact of mixed reality on museum visitor experience and satisfaction. It designs a conceptual framework of seven dimensions and 23 items influencing human-technology interaction and experience in a museum.

This paper aims to contribute to advances in research on visitor experience analysis in museums, applying the Trunfio and Campana's (2019) visitor experience model for mixed reality in museums. The empirical analysis interests 'The Ara As It Was', a mixed reality project installed in the iconic and historical Ara Pacis Museum in Rome (Italy). Findings, discussion and conclusion open new avenues of research and suggest managerial implications to improve museum competitiveness.

2 Theoretical Background

New realities—including Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR)—have been receiving increasing attention in tourism and cultural heritage research (Guttentag, 2010; He et al., 2018; Jung et al., 2018; Yung & Khoo-Lattimore, 2019).

The literature identifies the concept of new realities as technologies redesigning the real-virtual continuum phenomenon, integrating reality with virtual space and providing multimedia representations of real-life and past and/or imaginative events (Yung & Khoo-Lattimore, 2019). AR embeds digital and synthetic multimedia information in real-life contexts, amplifying the degree of user information acquisition (He et al., 2018; Jung et al., 2015); VR promotes alternative world visualisation through different levels of immersion and interaction (Guttentag, 2010). Finally, MR represents a continuum immersive link in an environment characterised by virtual and real elements (Bekele et al., 2018; Milgram & Kishino, 1994).

AR and VR present differences in users' levels of both immersion and presence (Guerra et al., 2015; Guttentag, 2010; Jung et al., 2018; Wei et al., 2019). Indeed, with AR, users augment their own visualisation level of information while remaining in a familiar real-world through action-simulation. With VR, users live a multidimensional psychological illusion to participate in the virtual contexts, isolated from real world (Guttentag, 2010; Wang et al., 2018; Wei et al., 2019).

Museums represents one of the main areas of research preferred spaces in which analyse opportunities and risks of experiences under conditions of new realities. They

create new elements supporting museum exhibitions—visualisation, immersion and interaction—redesigning the organisation of a cultural site-visit as an immersive experience in which firstly, experiential learning is combined with edutainment, secondly, heritage preservation is enhanced (Bec et al., 2019; Bekele et al., 2018; Guttentag, 2010; Han et al., 2013; He et al., 2018; tom Dieck & Jung, 2017; Trunfio & Campana, 2019; Yung & Khoo-Lattimore, 2019).

Their application introduces alternative scenarios of heritage exhibition management reinforcing the link between visitors immersive experience and the virtual interaction with cultural and historical artefacts (Bec et al., 2019). By facilitating integration between real and virtual settings, new realities ensure full visitor immersion and overall engagement in the museum experience (Trunfio & Campana, 2019).

Research on VR and AR in museums covers visitors' motivations, critical factors and benefits, and service features able to increase user intentions and their emotional experience (Del Chiappa et al., 2014; Guttentag, 2010; Poria et al., 2006; Rauschnabel & Ro, 2016; Trunfio et al., 2018; Jung et al., 2018).

Although such technologies present diverse opportunities, their application requires constant monitoring and testing of the latest solutions available on the market, in order to identify the strengths and weaknesses of diverse tools. User requirements, technology acceptance and intention (Chung et al., 2015, 2018; Han et al., 2018) are still considered to be the main challenges for scholars and museum organisations. The user interface should have a simple and authentic design giving prompt access to required information. It requires usability in order to provide an easy utilisation and an authentic experience. Information needs to be relevant and updated and the content communicated without difficulty. An important aspect is the size of the application, its speed and loading times. Social networking and reviewing are gaining importance. Efficiency and time saving is a key theme, as is ease of use.

A recent model of user experience for augmented reality in urban heritage tourism has been proposed (Han et al., 2018), identifying factors that influence AR acceptance and satisfaction, and improving the effectiveness of product features. It proposes applications in urban heritage tourism in terms of content, presentation, functionality and interaction describing product features.

Building upon relevant literature and Han et al.'s (2018) model, Trunfio and Campana (2019) propose a novel conceptual model capturing the value of mixed reality in a museum service model and its effects on visitor experience.

The Trunfio and Campana's (2019) visitor experience model for mixed reality in museums designs a conceptual framework of seven dimensions and 23 items measuring experience and satisfaction.

3 Case Study

'The Ara As It Was' represents a mixed reality project installed in the iconic and historical Ara Pacis Museum in Rome (Italy). It was developed by the Experience Designer ETT S.p.a., a company specialising in new technologies and multimedia



Fig. 1 The Ara Pacis Museum in Rome

tools, to enhance the value of the Ara Pacis monument, built between the 13th and 9th centuries BCE (Fig. 1). A 3D tracking system was applied to this project, making use of the most advanced computer vision algorithms.

The entire Augmented Reality system recognises three-dimensional bas-reliefs and carries out real-time tracking, increasing the effectiveness of this immersive experience.

The project was conceived for evening museum visits. Each visitor receives a Samsung Gear VR viewer that, combined with a Samsung S7 smartphone, shows not only Virtual Reality content but also triggers content in Augmented Reality. There are nine points of interest (POIs) along the visit route. Wearing Samsung Gear VR visors, spectators are greeted with a 360° video of the Ara Pacis as it is today, before finding themselves in a white space in which the monument appears in its original colours.

In the Ara Pacis project, the combination of the AR and VR enhances the user experience and give results to one of the most important monument's history, providing a hybrid approach experience to monument visitors.

4 Methodology

The Trunfio and Campana's (2019) visitor experience model, for mixed reality in museums (Table 1), was applied to 'The Ara As It Was', a mixed reality project

Table 1 The visitors' experience model for mixed reality in museums

Dimensions	Items
Museum information	Exhibition
	Service
	Historical period
	City attraction
Customisation	Personalised information
	Multiple language capability
Format	Audio
	Images and video
	Accessible using own mobile device
	Touch
Usability	Comfort
	Clever alternative to access information
	Easy to use
Information saving	On personal devices
	On museum platforms
Interaction	Museum servicescape
	Multimedia elements
	Other technologies
Experience	Heritage valorisation
	Educational
	Entertainment
	Socialisation
	Escape

Source Trunfio and Campana (2019)

installed in the iconic and historical Ara Pacis Museum in Rome (Italy). The project is regarded as an innovative space in which to test the model, using an empirical analysis in which mixed reality enhances the value of this historical monument, considered to be an important Roman artistic masterpiece.

The Trunfio and Campana (2019) model comprises seven dimensions and 23 items, integrating functional elements of mixed reality (six dimensions and eighteen items) and experiential elements (one dimension and five items) that measure the mixed reality effect on the visitor experience. Functional elements consider the following dimensions (and items): museum information (items: exhibition, service, historical period and city attraction), customisation (items: personalised information and multiple language capabilities), format (items: audio, images and video, accessible on personal mobile devices, and touch), usability (items: comfort, clever alternative to access information and easy-to-use), information saving (items: on

personal devices and on museum platforms) and interaction (items: museum servicescape, multimedia elements and other technologies). The experience dimension considers items to be heritage valorisation, educational, entertainment, socialisation and escape.

The 18 functional items of the Trunfio and Campana's (2019) model was measured considering two sections for each item using a seven-point Likert scale: the first measuring the level of expectations (importance); and the second the level of satisfaction (performance).

The interviews were conducted at two separate times, before the visitor experience and after the visit, in order to evaluate the level of satisfaction/performance (seven-point Likert scale).

Data collection was obtained from July to December 2018, through face-to-face interviews in the museum and selecting 726 visitors with simple random sampling (Wang et al., 2012).

Data were analysed using the Statistical Package for Social Sciences 11 (SPSS). The importance and performance analysis (IPA), one of the most common methodological tools in tourism and service research (Lai & Hitchcock, 2015), revealed the strategic position of the 18 functional items of the Trunfio and Campana's (2019) model in a matrix measuring the level of importance and performance.

5 Results and Discussion

Findings allows to underlines how Italians represent the majority of visitors to the Ara Pacis Museum (65%) followed by foreign visitors, where the main countries are USA (7.7%), Germany (6.4%), Spain and UK (3.8%). Female visitors were 53.2% and the most representative age group was from 20 to 29 (23.1%), followed by 30–39 (21.8%) and 40–49 (19.2%). Visitors with a high level of education prevail (37.8% with a university degree) and the majority are either employees (38.7%) or students (22.6%).

Interesting results emerged when applying the importance and performance analysis on the Trunfio and Campana's (2019) model.

Visitors attributed a medium-high level of importance (seven-point Likert scale) to all items ranging from 4.82 (socialisation) to 6.54 (images and video).

The results showed a high level of overall satisfaction (5.36), confirming the effectiveness and innovativeness of the project. The satisfaction value ranges from 4.06 (touch) to 6.13 (multiple-language capability and audio).

Visitor expectations (importance) and satisfaction (performance) can be analysed considering two importance-performance matrices measuring the functional aspects of mixed reality in the museum (Fig. 2). They show the success of 'The Ara as It Was', a mixed reality project installed in the iconic and historical Ara Pacis Museum in Rome (Italy).

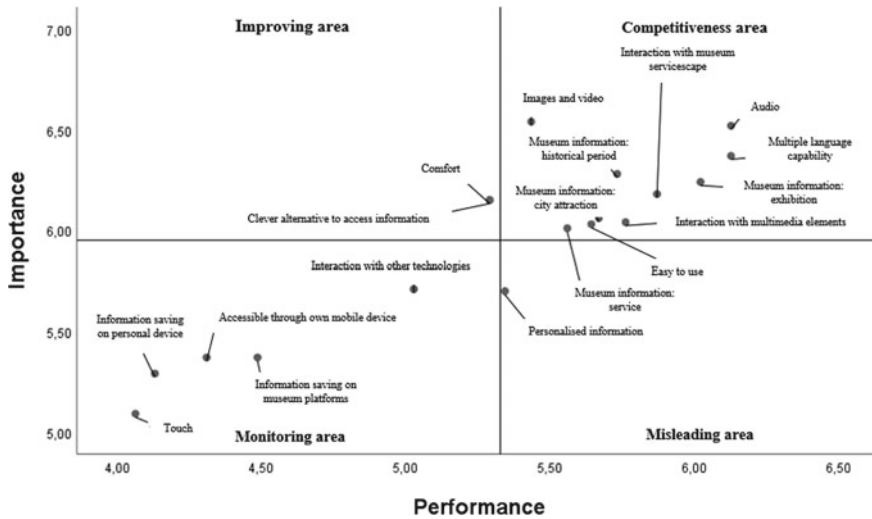


Fig. 2 Visitors' perception of mixed reality applications in the Ara Pacis Museum

Visitor perception of ten items describing mixed reality applications in the Ara Pacis Museum present a high level of expectation and satisfaction, covering the competitiveness area (Fig. 2).

The presence of ten items in the competitiveness area confirms the central role of MR technologies in creating innovative storytelling, content and knowledge, facilitating the museum visit and increasing visitor satisfaction.

Other interesting items in the quadrant of competitiveness are image, video and audio (format dimension), museum servicescape and multimedia elements (interaction dimensions), multiple language capabilities (customisation dimension) and easy to use (usability dimension). Their positioning in the quadrant of competitiveness shows how MR improves the active role of the visitor during the museum fruition, interacting easily with both the servicescape and multimedia tools.

Sophisticated audios, images and videos, in diverse languages, reinforce the visitor immersion state in the real-virtual landscape (Wang et al., 2018; Wei et al., 2019), allowing the process of service museum re-organisation towards new forms of experiences.

The monitoring area covers space in which the visitors position elements with a low level of both importance and satisfaction in an immersive museum visit.

Five items cover the monitoring area such as accessibility on own mobile device and touch (format dimension); other technologies (interaction dimension); and information saving on personal devices and on museum platforms (other dimension).

These results are coherent with the Ara Pacis Museum approach which does not allow the reproduction of MR technology on visitors' mobile devices. They

consider that integration with other technologies and saving information or memories on smartphones or museum platforms are functions that reduce the immersive experience, distracting visitors.

The last three items cover unusual positioning. Although very close to the competitiveness area, the comfortable and clever alternative to accessing information (usability dimension) expresses visitor limits when wearing Samsung Gear during the visit to access alternative information. Similarly, personalised information (customisation dimension) covers the misleading area but is very close to the monitoring area. Improving the level of personalised information can represent a future challenge offering different levels of information through MR for both expert and general visitors.

6 Conclusion

Museums are exploiting new reality opportunities to redesign their service proposal and create unique experiences as an immersive site-visit, combining experiential learning with innovative forms of entertainment and recreation (Jung & tom Dieck, 2017; tom Dieck et al., 2018; Trunfio & Campana, 2019). Overlaying the physical environment with multimedia elements and digital content, they provide a multi-dimensional awareness in which the user's psychological presence and the immersion in a virtual landscape are combined with surrounding context, substituting or integrating the real experience of visitors (He et al., 2018; Wang et al., 2018).

'The Ara As It Was' is a successful combination of advanced technology and innovative storytelling increasing visitor presence and participation. The content is the core of storytelling, indeed the reconstruction of the original colours on the monument works as the storyteller, creating an immersive trail around it. This experience certainly marks a very important step in re-evaluating the role that new multimedia technologies have within the enhancement processes and the improvement of both content and research.

The research also confirms the new role of museums as an immersive culture site combining heritage elements with multimedia formats (He et al., 2018; Trunfio & Campana, 2019). By leveraging on mixed reality, 'The Ara As It Was' project innovates and reshapes the iconic and historical Ara Pacis Museum in Rome, creating an immersive site-visit in which the combination between experiential learning and entertainment enhances visitor presence and satisfaction. Although preliminary, this research confirms some theoretical and managerial implications but it starts to explore new areas for future research, as well as spaces enhancing innovation in technological tools. Some theoretical implications emerge.

Firstly, the Trunfio and Campana's (2019) visitor experience model for mixed reality in museums can be applied, considering specific items such as interaction with museum servicescape and multimedia elements (interaction dimension); exhibition, service, historical period and city attraction (museum information dimension); audio

and image and video (format dimension), multiple language capability (customisation dimension) and easy to use (usability dimension). A new museum business model may be tested (Trunfio & Campana, 2019) in which interactions between visitors, museum servicescape and multimedia technology combine authenticity with innovation.

Secondly, the importance and performance analysis evidences how functional elements reducing the sense of presence during the experience (Wang et al., 2018) receive low importance, calling scholars and practitioners to focus on the key service features to enhance visitor satisfaction and museum competitiveness.

Thirdly, this paper accepts the challenge to contribute with effective human-technology interaction in museums to explore how historical, artistic and cultural values can be combined with a new experiential visit. It creates the managerial condition for heritage preservation and virtual accessibility (Bekele et al., 2018; Guttentag, 2010).

Last, but not least, 'The Ara As It Was' project proposes an innovative service model in which revenue and new job opportunities create synergies and service value, enhancing the reputation of the museum and generating multi-target mobile applications.

Museum managers can learn from this account on the diverse factors of the mixed reality experience when defining new strategic scenarios and re-evaluating investments. Future challenges will be able to widen the analysis of MR in museums to other typologies of the museum—such as industrial and science museums etc.—in order to define possible technology-human-service interaction models.

References

- Bec, A., Moyle, B., Timms, K., Schaffer, V., Skavronskaya, L., & Little, C. (2019). Management of immersive heritage tourism experiences: A conceptual model. *Tourism Management*, 72, 117–120.
- Bekele, M. K., Town, C., Pierdicca, R., Frontoni, E., & Malinverni, E. S. (2018). A Survey of augmented, virtual, and mixed reality for cultural heritage. *Journal on Computing and Cultural Heritage*, 11(2), 7–36.
- Chung, N., Han, H., & Joun, Y. (2015). Tourists' intention to visit a destination: The role of augmented reality (AR) application for a heritage site. *Computers in Human Behavior*, 50, 588–599.
- Chung, N., Lee, H., Kim, J. Y., & Koo, C. (2018). The role of augmented reality for experience-influenced environments: The case of cultural heritage tourism in Korea. *Journal of Travel Research*, 57(5), 627–643.
- Del Chiappa, G., Andreu, L., & Gallarza, M. G. (2014). Emotions and visitors' satisfaction at a museum. *International Journal of Culture, Tourism, and Hospitality Research*, 8(4), 420–431.
- Fenu, C., & Pittarello, F. (2018). Svevo tour: The design and the experimentation of an augmented reality application for engaging visitors of a literary museum. *International Journal of Human Computer Studies*, 114, 20–35.
- Guerra, J. P., Pinto, M. M., & Beato, C. (2015). Virtual reality—shows a new vision for tourism and heritage. *European Scientific Journal*, 11(9), 49–54.

- Guttentag, D. A. (2010). Virtual reality: Applications and implications for tourism. *Tourism Management*, 31(5), 637–651.
- Han, D. I., Jung, T. H., & Gibson, A. (2013). Dublin AR: Implementing augmented reality in tourism. In *Information and communication technologies in tourism 2014*. (pp. 511–523). Cham: Springer.
- Han, D. I., tom Dieck, M. C., & Jung, T. H. (2018). User experience model for augmented reality applications in urban heritage tourism. *Journal of Heritage Tourism*, 13(1), 46–61.
- He, Z., Wu, L., & Li, X. (2018). When art meets tech: The role of augmented reality in enhancing museum experiences and purchase intentions. *Tourism Management*, 68, 127–139.
- Jung, T. H., Chung, N., & Leue, M. C. (2015). The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park. *Tourism Management*, 49, 75–86.
- Jung, T. H., & tom Dieck, M. C. (2017). Augmented reality, virtual reality and 3D printing for the co-creation of value for the visitor experience at cultural heritage places. *Journal of place Management and Development*, 10(2), 140–151.
- Lai, I. K. W., & Hitchcock, M. (2015). Importance-performance analysis in tourism: A framework for researchers. *Tourism Management*, 48, 242–267.
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual-displays. *IEICE Transactions on Information and Systems*, 77(12), 1321–1329.
- Poria, Y., Reichel, A., & Biran, A. (2006). Heritage site management: Motivations and expectations. *Annals of Tourism Research*, 33(1), 162–178.
- Rauschnabel, P. A., & Ro, Y. K. (2016). Augmented reality smart glasses: An investigation of technology acceptance drivers. *International Journal of Technology Marketing*, 11(2), 123–148.
- tom Dieck, M. C., & Jung, T. H. (2017). Value of augmented reality at cultural heritage sites: A stakeholder approach. *Journal of Destination Marketing and Management*, 6(2), 110–117.
- tom Dieck, M. C., Jung, T. H., & tom Dieck, D. (2018). Enhancing art gallery visitors' learning experience using wearable augmented reality: generic learning outcomes perspective. *Current Issues in Tourism*, 21(17), 2014–2034.
- Trunfio, M., & Campana, S. (2019). A visitors' experience model for mixed reality in the museum. *Current Issues in Tourism*, 1–6.
- Trunfio, M., Magnelli, A., Della Lucia, M., Verreschi, G., & Campana, S. (2018). Augmented and virtual reality in cultural heritage: Enhancing the visitor experience and satisfaction at the Area Pacis museum in Rome, Italy. In *8th Advances in Hospitality and Tourism Marketing and Management (AHTMM) Conference*. (pp. 673–685). Bangkok, Thailand.
- Tussyadiah, I. P., Jung, T. H., & tom Dieck, M. C. (2018). Embodiment of wearable augmented reality technology in tourism experiences. *Journal of Travel Research*, 57(5), 597–611.
- Tussyadiah, I. P., Wang, D., Jung, T. H., & tom Dieck, M. C. (2018). Virtual reality, presence, and attitude change: Empirical evidence from tourism. *Tourism Management*, 66, 140–154.
- Wang, J. F., Stein, A., Gao, B. B., & Ge, Y. (2012). A review of spatial sampling. *Spatial Statistics*, 2, 1–14.
- Wei, W., Qi, R., & Zhang, L. (2019). Effects of virtual reality on theme park visitors' experience and behaviors: A presence perspective. *Tourism Management*, 71, 282–293.
- Yung, R., & Khoo-Lattimore, C. (2019). New realities: A systematic literature review on virtual reality and augmented reality in tourism research. *Current Issues in Tourism*, 22(17), 2056–2081.