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VIRTUAL PATHS TO THE PAST: EVALUATING VISITORS EXPERIENCE AT DIGITAL ENHANCED HERITAGE SITES

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Abstract: The study investigates how digital interpretation tools impact visitor experiences at cultural heritage sites in Serbia, focusing on satisfaction, emotional and cognitive engagement, educational outcomes, and ease of use. In response to evolving visitor expectations and the growing integration of digital technologies in tourism, this research addresses gaps related to demographic variations and lesser-known heritage sites in Southeast Europe. A mixed-methods approach was employed, combining a quantitative survey (N=150) with qualitative interviews (30 participants) across three culturally significant sites—Belgrade Fortress, Felix Romuliana, and Mokra Gora. These sites were selected for their cultural prominence and differing levels of technological integration, allowing for a nuanced exploration of visitor interactions with digital tools. Results reveal that digital tools, such as augmented reality, virtual reconstructions, and interactive apps, enhance learning, foster emotional connection, and increase visitor satisfaction, particularly among younger and first-time visitors. However, older adults and those with limited digital literacy reported usability challenges, highlighting the need for inclusive design and multilingual options. Regression analysis confirmed that emotional engagement and immersive storytelling strongly predict satisfaction. The study also demonstrates that digital tools facilitate experiential learning, enabling visitors to internalize historical narratives more deeply than through traditional methods. Qualitative findings emphasize the role of personal, narrative-driven content in shaping memorable and meaningful site experiences. By providing a holistic, multi-dimensional evaluation, this research advances the discourse on digital heritage tourism, emphasizing the importance of adaptive, demographically sensitive, and culturally contextualized digital strategies. The study offers practical recommendations for site managers and designers, advocating for inclusive, emotionally engaging, and locally grounded digital experiences that cater to diverse visitor profiles.

Keywords: digital heritage tourism, visitor experience, augmented reality, cultural interpretation, engagement and learning, usability

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INTRODUCTION

In recent years, the integration of digital technologies into cultural heritage tourism has transformed the way visitors engage with, learn from, and experience historical sites. Augmented reality (AR), virtual reconstructions, interactive kiosks, and mobile storytelling apps are increasingly being used to supplement traditional interpretive materials, offering new pathways for immersion, emotional connection, and learning (Cahyani et al., 2023; Tsoukala et al., 2025).

These innovations have been widely praised for enhancing visitor satisfaction, fostering deeper engagement, and facilitating personalized, emotionally resonant experiences (Roodposhti & Esmaeelbeigi, 2024; Wang et al., 2025).

Moreover, the educational potential of digital tools is gaining attention, with studies showing that narrative-driven technologies can significantly improve comprehension, knowledge retention, and reflective learning (Kaeophanuek et al., 2019). Despite these advancements, several critical issues remain underexplored. Despite the growing body of research on digital heritage interpretation, several recent studies highlight critical gaps that remain underexplored.

For example, Yoo & Yu (2024) examined the role of augmented reality (AR) in enhancing learning outcomes in cultural heritage settings, demonstrating positive effects on visitor engagement and knowledge acquisition. However, their study was limited to technologically advanced museum environments and did not address variations in visitor demographics or outdoor heritage sites. Similarly, Shahab et al. (2023) focused on the use of virtual reality (VR) in museum contexts and found significant improvements in visitor enjoyment and learning.

Nevertheless, they acknowledged that the high costs of VR installations and their dependence on controlled indoor environments limit their applicability for open-air heritage sites. Privitera et al. (2025) reviewed immersive storytelling

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in heritage tourism, emphasizing the growing importance of audio-based narratives. However, their analysis was largely conceptual and did not include empirical testing or visitor feedback from diverse user groups. Further, Zhang et al. (2025) investigated tourist experiences in Chinese heritage sites using a tripartite engagement model. Their findings confirmed the importance of emotional and cognitive engagement but were primarily focused on domestic tourists, limiting generalizability to international visitors or less globally known heritage locations. Finally, Cahyani et al. (2023) analyzed digital storytelling in Southeast Asia, focusing on its role in sustainable heritage tourism. Although their study highlighted the benefits of localized narratives, it did not explore usability challenges or demographic factors such as age and digital literacy, which are increasingly relevant in digital heritage tourism. Taken together, these studies offer valuable insights but also present notable limitations in terms of sample diversity, contextual scope, and analytical frameworks. Many focus on iconic or technologically advanced sites, overlooking smaller or less resourced destinations.

Furthermore, several studies neglect cross-demographic analyses or fail to consider usability issues faced by older or less digitally literate visitors. Our study addresses these gaps by offering a multi-site, mixed-methods analysis that incorporates demographic variables and usability assessments in both indoor and outdoor heritage contexts.

Also, much of the existing literature has focused on high-profile international heritage sites, leaving a gap in our understanding of how digital tools function in regional and less globally known destinations, particularly in Eastern Europe (Gburová et al., 2024; Liu, 2020). While studies often assess isolated aspects such as satisfaction or usability, there is a lack of integrative research that simultaneously examines visitor satisfaction, engagement, educational outcomes, and ease of use within the same analytical framework (Abou Kamar et al., 2024; Yoo & Yu, 2024). Finally, many investigations overlook demographic variation in how different user groups perceive and interact with digital content—an omission that is increasingly relevant as cultural heritage sites aim to accommodate diverse audiences with varied digital literacy levels (Sylaiou et al., 2025; Yung & Khoo-Lattimore, 2019). Addressing these gaps, the present study investigates the impact of digital interpretation tools on visitor experiences across three cultural heritage sites in Serbia.

Researching the role of digital tools in cultural heritage tourism is particularly important in light of shifting visitor expectations, the growing demand for immersive and educational experiences, and the increasing digitalization of the tourism sector (Tussyadiah, 2020; Zhang et al., 2022). As global travelers become more tech-savvy and culturally curious, heritage sites are expected not only to preserve the past but also to communicate it in engaging, accessible, and pedagogically effective ways (Yung & Khoo-Lattimore, 2019; Privitera et al., 2025). Digital interpretation tools offer the potential to bridge generational, linguistic, and cognitive gaps by making historical narratives more interactive and personally meaningful (Chang & Suh, 2025; Yoo & Yu, 2024). However, without systematic research into how different audiences actually perceive and use these tools, there is a risk of implementing technologies that fail to meet user needs or even detract from the authenticity of the heritage experience (Graziano & Privitera, 2020; Dieck & Jung, 2018; Jojić Glavonjić et al., 2017).

The main aim of this study is to systematically evaluate the impact of digital interpretation tools (such as augmented reality (AR) mobile applications, virtual reconstructions, interactive kiosks, QR codes, and audio guides) on visitor experiences at cultural heritage sites in Serbia. Specifically, the research examines how these digital tools influence four key dimensions of the visitor experience: satisfaction, emotional and cognitive engagement, educational outcomes, and usability. In addition to assessing the overall effects of digital heritage technologies, the study also explores how demographic factors—such as age, educational background, and prior experience with digital tools—shape visitor perceptions and experiences. To achieve these objectives, the study applies a mixed-methods research design, combining quantitative survey methods with qualitative interviews. This methodological approach enables both breadth and depth of analysis: the quantitative component provides measurable patterns and statistical relationships, while the qualitative component captures nuanced, subjective visitor experiences and emotional responses that cannot be fully addressed through structured surveys alone. By integrating these methods, the study offers a more comprehensive, context-sensitive understanding of the opportunities and challenges associated with digital interpretation in heritage tourism.

LITERATURE REVIEW

1. Visitor satisfaction in digital heritage tourism

In the context of digital heritage interpretation, satisfaction is increasingly shaped not only by the physical and historical aspects of a site, but also by the quality and effectiveness of digital enhancements (Tussyadiah, 2020). Recent studies emphasize that immersive digital tools can significantly enhance visitor satisfaction by enriching interpretation and promoting deeper emotional connections to heritage narratives. For example, tom Dieck et al. (2016) showed that mobile AR apps improved satisfaction by making the content more engaging, accessible, and personalized.

These findings are supported by Zhang et al. (2022), who demonstrated that interactive and visually appealing digital tools not only improve understanding of cultural content but also increase the perceived quality of the overall experience. However, some studies present more nuanced or mixed findings. While van Nuenen & Scarles (2021) acknowledge the benefits of digital tools, they also caution that over-reliance on technology without contextual storytelling may reduce satisfaction, especially if visitors feel overwhelmed or disconnected from the physical site. Similarly, Zhang et al. (2025) observed that technical glitches, limited multilingual support, or poorly designed interfaces can detract from the overall experience, highlighting that satisfaction is not guaranteed solely through the presence of digital technology. Notably, research has also explored the emotional dimension of satisfaction, linking it to the narrative power and affective resonance of digital interpretation.

For instance, Nagy at al. (2022) found that satisfaction was strongly influenced by the degree to which digital storytelling evoked curiosity, nostalgia, or emotional immersion. Comparative studies across cultural settings have also

revealed some differences in how digital tools influence satisfaction. For example, Zhang et al. (2024) reported that visitors at high-profile, international heritage sites tend to expect sophisticated digital offerings, and are more critical when the tools do not meet usability or interpretive standards. In contrast, visitors at lesser-known regional sites often express high satisfaction with even basic digital enhancements, perceiving them as added value (Hussein & Al Ali, 2025).

2. Visitor engagement and digital storytelling

As cultural heritage sites adopt digital storytelling tools such as augmented reality (AR), virtual tours, and immersive multimedia content, the potential to foster deeper visitor engagement has significantly expanded. Contemporary research consistently demonstrates that digital storytelling enhances engagement by making cultural content more relatable, interactive, and emotionally resonant. According to Privitera et al. (2025), AR-based storytelling increases visitors' emotional involvement by providing real-time, contextual overlays that create a sense of "being there". Emotional engagement, in particular, is seen as a crucial predictor of satisfaction, memory retention, and revisit intention (Yung & Khoo-Lattimore, 2019). Cognitive engagement, which includes curiosity, attention, and knowledge-seeking behavior, is also positively influenced by narrative-driven digital media (Passebois Ducros & Euzeby, 2021).

The Cognitive-Affective-Conative (CAC) model of engagement, originally proposed in consumer behavior research (Hollebeek et al., 2014), has been increasingly applied in tourism to conceptualize how visitors process and respond to interpretive stimuli. Studies adopting this framework show that emotional engagement often acts as a bridge between cognitive stimulation (e.g., curiosity or learning) and conative responses (e.g., active participation, advocacy) (Chang & Suh, 2025). However, Li et al. (2025) found that first-time visitors to cultural sites were more emotionally impacted by AR narratives than repeat visitors, who demonstrated higher cognitive engagement due to pre-existing knowledge. Some studies offer critical perspectives, warning that overly technologized experiences may reduce engagement if they fail to align with the cultural authenticity or historical significance of the site (Liritzis et al., 2015).

Another significant strand of literature focuses on story-driven versus information-driven engagement. Research by Cesario & Campos (2024) suggests that storytelling techniques rooted in personal, emotional, or character-based narratives outperform purely informational content in sustaining visitor attention and empathy. This is further echoed by Kasemsarn & Nickpour (2025), who found that digital narratives incorporating local voices, myths, or reconstructed scenes elicited stronger behavioral engagement (e.g., participation in on-site activities, social sharing).

3. Educational outcomes and heritage learning

Multiple studies have found that interactive and immersive technologies promote better educational outcomes than traditional static interpretation methods. For instance, Yoo & Yu (2024); Challenor & Ma (2019) showed that AR-based museum applications significantly improved learners' comprehension and recall of historical content due to the combination of visual stimuli and spatial immersion. These findings are echoed by Shahab et al. (2023), who report that storytelling elements, when embedded within digital formats, foster both cognitive engagement and long-term memory retention. Visitors are more likely to retain knowledge when they feel personally connected to the story being told.

This aligns with constructivist learning theory, which posits that knowledge is more meaningfully internalized when learners actively construct it through experience and reflection. However, not all studies are unanimous in their conclusions. For example, Giacobone et al. (2024) warn that overstimulating environments may lead to cognitive overload, which can hinder comprehension, especially among older or less digitally literate visitors. This suggests the need for adaptive and inclusive digital learning designs that accommodate diverse user preferences and cognitive styles.

An emerging trend in the literature also highlights personalized and participatory learning as central to impactful heritage education. For instance, Lacko (2019) suggest that digital tools that allow users to control pacing, select content pathways, or contribute user-generated interpretations foster more meaningful and memorable learning.

4. Ease of use and technology acceptance in heritage sites

Grounded in Davis's (1989) Technology Acceptance Model (TAM), perceived ease of use and usefulness are the two core predictors of user acceptance and adoption of digital systems. In the context of heritage tourism, ease of use refers to how intuitively and effortlessly visitors can interact with digital tools. Recent studies strongly affirm that ease of use significantly influences overall visitor satisfaction and engagement. Graziano & Privitera (2020) found that tourists who perceived AR-based tools as easy to navigate reported higher satisfaction and were more likely to engage with interpretive content. Similarly, tom Dieck & Jung (2018) demonstrated that perceived simplicity of interface design in wearable AR applications directly affected emotional immersion and learning outcomes in museum settings.

However, while usability is often associated with positive outcomes, research also reveals that usability challenges can significantly hinder technology acceptance, particularly among older visitors or those with lower digital literacy. For instance, Yung & Khoo-Lattimore (2019) observed that complex navigation, unclear instructions, and a lack of guidance diminished engagement and led some visitors to abandon the technology altogether. Similar concerns were raised by Poux et al. (2020), who emphasized the need for adaptive interface design that accommodates varying levels of user experience and cognitive ability, particularly in cross-generational and international contexts.

Language accessibility is another critical but often overlooked factor affecting ease of use. In regions where digital content is primarily presented in the local language, non-native speakers may struggle to navigate the tools effectively, thus diminishing their overall experience. Importantly, recent literature stresses that usability must be considered not only at the technical level but also in terms of narrative structure and contextual relevance. Vrettakis et al. (2019) argue

that even technically functional tools may fail to engage users if the content feels fragmented, too abstract, or disconnected from the physical site. Therefore, usability in heritage technology must encompass both interface design and interpretive logic—the way digital tools guide users through a coherent, meaningful experience.

METHODOLOGY

1. Sample and procedure

Three case study locations in Serbia were selected based on their integration of digital heritage interpretation tools and their cultural significance: Belgrade Fortress (Kalemegdan), Felix Romuliana (Gamzigrad), and the Šargan Eight Railway & Mokra Gora Ethno-Village (Drvengrad). Digital tools implemented at Belgrade fortress include the "Kalemegdan AR" mobile application, which allows users to explore 3D reconstructions of past structures and battles, as well as QR codes that provide access to interactive stories and audio guides (Novaković et al., 2024).

Felix Romuliana, located near Zaječar and designated as a UNESCO World Heritage Site, presents digital storytelling through virtual reconstruction videos and interactive kiosks that illustrate Roman-era architecture and daily life (Marjanović et al., 2024). The third location, Šargan Eight Railway and Mokra Gora Ethno-Village (Drvengrad) in Western Serbia combines scenic rail tourism with cultural immersion. Visitors engage with mobile apps and kiosks offering historical information, virtual train route maps, and video storytelling (Medar-Tanjga et al., 2022; Ristić et al., 2024).

The quantitative component involved a structured survey conducted with 150 visitors, with an equal distribution of 50 respondents per site. Respondents were approached on-site by trained research assistants during peak visiting hours and invited to complete the questionnaire either on paper or via a digital form using tablets. The questionnaire was available in both Serbian and English. The demographic profile of the survey participants included 54% female and 46% male respondents. In terms of age, 26% were between 18 and 29 years old, 39% between 30 and 44, 24% between 45 and 59, and 11% were 60 years or older. Educational background varied, with 21% having completed secondary education, 48% holding a bachelor's degree, and 31% possessing a master's degree or higher.

While the majority of respondents were domestic tourists (72%), a significant proportion (28%) were international visitors, primarily from Western Europe and neighboring Balkan countries. For the qualitative component, semi-structured interviews were conducted with 30 visitors—10 per case study site—selected from among the survey participants to ensure diversity in age, gender, nationality, and prior experience with digital tools. Interviewees ranged in age from 22 to 67 years, with a mean age of approximately 39. The group included 17 females and 13 males, all of whom had at least secondary education; 22 of them held university degrees. These interviews were carried out in-person immediately following the site visits, lasting 20 to 30 minutes each, and explored the participants' subjective experiences, perceived emotional engagement, and reflections on how digital storytelling shaped their understanding of the heritage content.

2. Instruments

The study utilized two primary instruments to collect data: a structured questionnaire based on previously validated scales for the quantitative component, and a semi-structured interview guide for qualitative inquiry. Both instruments were designed to capture visitors' perceptions of digital tools at selected cultural heritage sites in Serbia. For the quantitative survey, the questionnaire comprised four key constructs: visitor satisfaction, engagement, educational outcomes, and ease of use.

Visitor Satisfaction was measured using six items adapted from the *Visitor Satisfaction Scale for Cultural Heritage Sites* developed by Di Pietro et al. (2016). A sample item includes: "I am satisfied with the quality of information provided about the cultural significance of the site". Responses were recorded on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Visitor Engagement was assessed using nine items from the *Destination Brand Engagement Scale* developed by Hollebeek et al. (2014). The scale is used to measure how tourists cognitively, emotionally, and behaviorally engage with a destination brand, while a sample item is „This destination brand is stimulating my curiosity".

Educational Outcomes were evaluated using six items adapted from the *Heritage Learning Outcomes Scale* developed by Packer & Ballantyne (2002). These items focused on perceived learning and knowledge retention. A sample item is: "I learned new and interesting facts about the site through the digital content".

Ease of Use was measured using five items based on the Technology Acceptance Model (TAM) developed by Davis (1989), particularly focusing on perceived usability of digital tools. A sample item is: "I found the digital tools easy to navigate and use during my visit". For the qualitative component, a semi-structured interview guide was developed to provide deeper insights into individual visitor experiences with digital heritage tools.

The guide included open-ended questions related to perceived emotional impact, usability of the digital features, perceived educational value, and suggestions for improving the digital content. Interviews were conducted on-site in either Serbian or English, recorded with consent, and later transcribed for thematic analysis.

3. Data analysis

Quantitative data analysis was conducted using IBM SPSS Statistics (version 24). Descriptive statistics, including means, standard deviations, and frequency distributions, were first calculated to summarize participant demographics and responses across the four main constructs: visitor satisfaction, emotional engagement, educational outcomes, and ease of use.

Reliability for each scale was assessed using Cronbach's alpha, with values above 0.70 indicating acceptable internal consistency. To examine the relationships among the study constructs, Pearson correlation analyses were performed. Furthermore, multiple regression analysis was conducted to determine the extent to which emotional engagement, educational outcomes, and ease of use predicted overall visitor satisfaction. One-way ANOVA tests were also employed to assess potential differences in satisfaction and engagement across the three case study locations. Statistical significance was set at the 0.05 level. Qualitative data analysis was performed using thematic analysis.

Interview transcripts were transcribed verbatim and coded manually using an inductive approach. Initially, open coding was applied to identify recurring patterns and visitor reflections. These codes were then grouped into broader themes such as emotional connection, cultural learning, technological usability, and enhancement of site authenticity.

A second round of coding ensured consistency and reliability in theme development. Supporting quotes from participants were selected to illustrate key findings and enrich the interpretation of survey data.

RESULTS

1. Demographic variation in perceptions of educational value and ease of use

To explore how demographic factors shape visitor perceptions of digital heritage tools, we conducted comparative analyses across age groups and educational levels. Results indicate that visitors' age and educational attainment influenced their experiences with both the usability and educational effectiveness of the digital content.

A one-way ANOVA revealed statistically significant differences in ease-of-use scores across age groups ($F(3, 146) = 4.72$, $p = .004$). The youngest group (18–29) reported the highest mean ease-of-use score ($M = 4.40$, $SD = 0.35$), while the oldest group (60+) had the lowest ($M = 3.88$, $SD = 0.52$). Post hoc Tukey tests confirmed significant differences between the 18–29 and 60+ groups. As visualized in Figure 1, younger respondents found the tools more intuitive and engaging, often describing them as "easy to follow" and "similar to mobile apps they already use."

In contrast, older visitors occasionally expressed frustration or hesitance. One respondent aged 62 noted: "*I'm not very used to touchscreen kiosks. I had to ask for help to find the language settings*". Educational level also showed effects, particularly regarding educational outcomes. Visitors with master's degrees or higher rated the digital tools more favorably for depth of understanding ($M = 4.38$) than those with only secondary education ($M = 3.95$), although differences were not statistically significant ($p = .067$). Nonetheless, qualitative responses suggested that higher-educated participants appreciated the thematic coherence and narrative structure of the digital content more explicitly.

A university-educated respondent stated: "*The videos connected the site's history to broader regional events. It helped me synthesize what I knew with what I saw*". Meanwhile, a visitor with secondary education remarked: "*The pictures and videos were nice, but I would've liked more basic explanations—some of it was too fast*".

Group	Ease of Use	Knowledge Retention	Depth of Understanding
18–29	4.4	4.32	4.18
30–44	4.25	4.35	4.22
45–59	4.1	4.15	4.05
60+	3.88	4	3.9
Secondary Educ.	4.05	4.1	3.95
Bachelor's Degree	4.22	4.3	4.15
Master's+ Degree	4.3	4.4	4.38

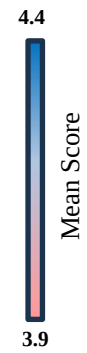

Figure 1. Visitor Perceptions of Digital Tools by Demographic Group (Source: Authors)

2. Visitor satisfaction

Quantitative analysis revealed generally high levels of visitor satisfaction across all three heritage sites. The mean satisfaction score was 4.28 ($SD = 0.54$) on a 5-point Likert scale, indicating that most visitors were pleased with their experience. Reliability analysis confirmed the robustness of the satisfaction scale, with a Cronbach's alpha of 0.84. Pearson correlation analysis showed that visitor satisfaction was significantly and positively associated with emotional engagement ($r = 0.62$, $p < .001$), educational outcomes ($r = 0.55$, $p < .001$), and ease of use of digital tools ($r = 0.49$, $p < .001$). ANOVA results suggested no statistically significant differences in overall satisfaction across the three case study sites $F(2,147) = 1.76$, $p = .175$, indicating a consistent level of satisfaction regardless of the specific destination.

Qualitative data supported these findings by revealing positive emotional reactions and appreciation for the digital enhancements provided at each location. One respondent at Kalemegdan stated: *The AR application made the fortress come alive. I could almost see the battle happening in front of me, which made the experience much more immersive than I expected. It wasn't just walking through ruins—I felt like I understood their meaning.* Similarly, at Felix Romuliana, a participant reflected: *The virtual reconstructions helped me imagine what the palace looked like in the Roman era. I've visited many ruins before, but this was the first time I felt emotionally connected to the history.*

These responses highlight how digital interpretation tools not only enhance understanding but also contribute to a more meaningful and satisfying encounter with archaeological heritage. At Mokra Gora, one visitor shared: *What I really liked was the mix of scenery and stories. As I sat on the train and listened to the audio about Kusturica and the*

village's history, I felt like part of a movie. It made the place more than just a tourist attraction—it became a story I was part of. These emotional and immersive experiences reflect how satisfaction in heritage tourism is often shaped not only by site quality but by interpretive depth enabled through technology.

In addition to analyzing overall satisfaction scores across the three case study sites, a focused linear regression analysis was conducted to examine the relationship between the perceived quality of immersive digital features and overall visitor satisfaction. As presented in Figure 2, the regression analysis yielded a statistically significant and strong positive relationship ($R^2 = 0.96$, $\beta = 0.94$, $p < 0.001$). This indicates that 96% of the variance in visitor satisfaction scores can be explained by the perceived quality of immersive digital features.

Specifically, for every one-point increase in the perceived rating of digital storytelling tools, visitor satisfaction increased by approximately 0.95 points on the 5-point scale. For example, participants who rated immersive features around 2.5 (low engagement) reported satisfaction scores close to 3.0, whereas those who rated immersive features a 5.0 (very high engagement) reported satisfaction scores reaching up to 5.0.

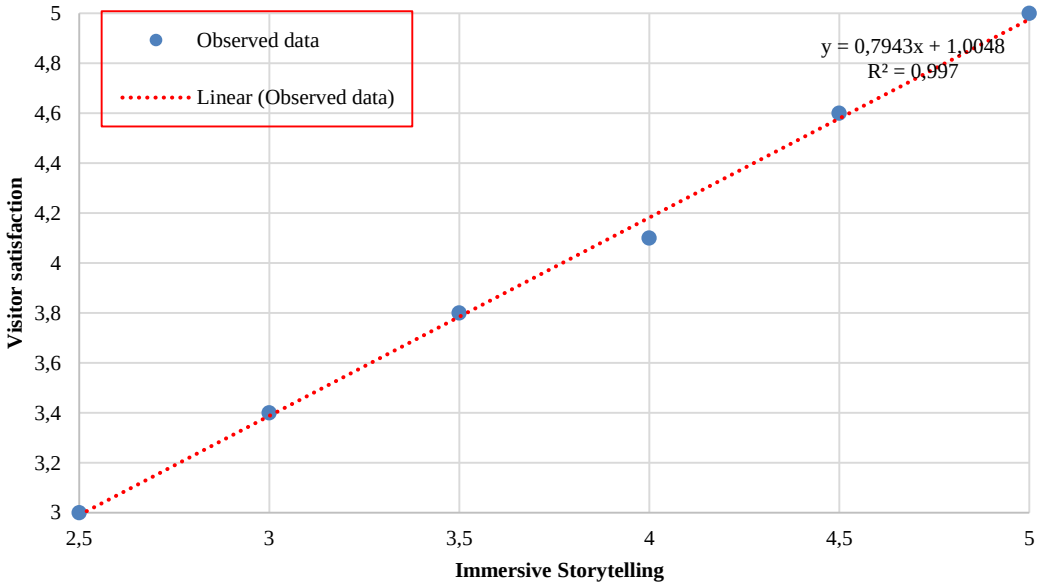

Figure 2. Relationship between immersive storytelling/AR features and visitors satisfaction (Source: Authors)

The visual trend in Figure 2 clearly demonstrates that better digital interpretation strongly correlates with more fulfilling and memorable visitor experiences, particularly in heritage tourism contexts where narrative depth and emotional connection are central.

3. Visitor engagement

The overall mean score for engagement was 4.20, with sub-dimensions ranging from 4.0 to 4.4. Among the sites, Mokra Gora consistently scored highest across all engagement types—cognitive (4.3), emotional (4.4), and behavioral (4.2)—suggesting that its immersive storytelling and interactive features foster a particularly compelling visitor experience. Qualitative insights strongly reinforce these findings. One visitor at Mokra Gora noted:

I felt transported into another world—it wasn't just seeing old things; it was feeling the story behind them. The digital narratives about the film director and the village made me feel like part of something. Meanwhile, visitors at Felix Romuliana acknowledged the site's historical value but occasionally desired deeper immersion: *The videos helped me understand the Roman palace, but I wish there were more personal stories or interactive elements.*

These results suggest that emotional and cognitive engagement—particularly when supported by compelling digital storytelling—significantly enhance the perceived value of cultural heritage experiences.

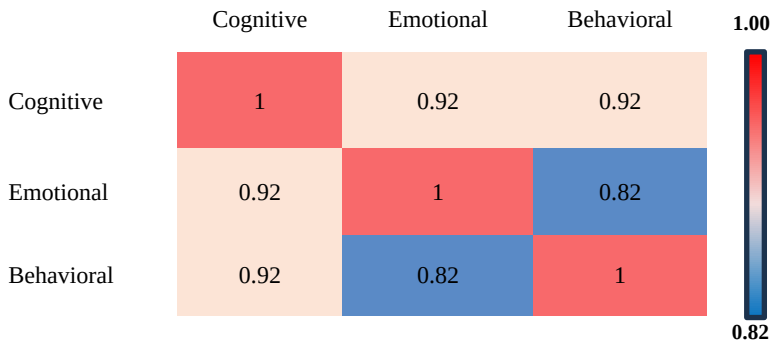

Figure 3. Correlation matrix of engagement dimensions (Source: Authors)

To explore the internal structure of visitor engagement beyond site-specific variations, a general analysis was conducted using all responses across the three dimensions of engagement: cognitive, emotional, and behavioral. Descriptive statistics showed consistently high engagement scores, with emotional engagement averaging 4.30, followed by cognitive (4.20) and behavioral (4.13) on a 5-point scale. To assess the relationships among these dimensions, a Pearson correlation matrix was generated and visualized as a heatmap (Figure 3).

The analysis revealed strong, positive, and statistically meaningful associations among all engagement components. Specifically, cognitive and emotional engagement were highly correlated ($r = 0.93$), as were emotional and behavioral engagement ($r = 0.91$), and cognitive and behavioral engagement ($r = 0.88$). These results suggest that visitors who were emotionally engaged with the heritage content also tended to be more intellectually attentive and behaviorally involved during their visits. The strength of these correlations confirms the interdependence of the three engagement dimensions and supports the theoretical view of engagement as a holistic, multidimensional construct.

4. Educational outcomes

Quantitative results indicated that visitors perceived the digital tools at cultural heritage sites to be effective in enhancing their educational experience. On a 5-point Likert scale, the average score for knowledge retention was the highest at 4.35, followed by depth of understanding (4.20), and ability to recall facts (4.10). These findings suggest that immersive and interactive storytelling formats are particularly effective at fostering conceptual learning and long-term memory retention, rather than rote memorization. The slight drop in scores related to the ability to recall specific facts ($M = 4.10$) compared to knowledge retention ($M = 4.35$) may reflect the nature of digital heritage content, which tends to emphasize experiential learning and thematic narratives over the delivery of discrete informational units.

This interpretation aligns with qualitative feedback from participants who noted that they remembered stories, visuals, and emotional impressions more vividly than isolated historical data. For example, one visitor shared:

I don't remember the exact date the palace was built, but I do remember the story about the emperor and his vision—that stayed with me. Many participants emphasized that digital tools helped them better understand complex historical content by contextualizing it within personal or narrative frameworks. One visitor at Felix Romuliana stated:

The interactive screen didn't just show ruins—it told the story of what daily life looked like. I could picture people walking around, not just stones. This illustrates how digital storytelling fosters not only factual learning but also empathetic and imaginative engagement, which can deepen understanding. Another participant at Mokra Gora shared:

I didn't expect to learn so much. The videos and maps helped me connect the place with events I had only vaguely heard about in school. This underscores how digital interpretation bridges gaps in prior knowledge, making content accessible regardless of a visitor's educational background. Importantly, even visitors who did not identify as "history enthusiasts" described feeling engaged and curious. As one noted: *I usually skip history museums, but this kept me focused. It was like watching a good documentary while walking through the actual setting.* These quotes reinforce the idea that educational value in heritage tourism is not simply about transferring facts, but about shaping perceptions, stimulating reflection, and creating meaningful personal connections to the past.

5. Ease of digital technology use

The results indicate that visitors found the digital tools used across the cultural heritage sites to be generally easy to use, with all assessed features receiving favorable ratings. The highest rated aspect was navigation simplicity ($M = 4.30$, $SD = 0.40$), followed closely by visual clarity ($M = 4.25$, $SD = 0.35$), suggesting that interfaces were intuitive and content was presented in an aesthetically accessible format. Slightly lower scores were observed for interactivity ($M = 4.10$, $SD = 0.45$) and language accessibility ($M = 4.05$, $SD = 0.50$), indicating room for improvement, particularly in tailoring content for international audiences and expanding multilingual options. Participants frequently commented on how the simplicity of navigation contributed to their overall satisfaction. One visitor noted: *The AR app was really straightforward. I didn't need instructions—it just worked*. Another shared: *Even my parents, who don't usually use digital tools, found it easy to follow the route and interact with the screens*. However, challenges were reported in terms of language limitations. As one international visitor observed: *Some of the deeper explanations were only in Serbian. I would have liked to get more from the experience if there were full translations.* These qualitative insights help explain the relatively lower mean score for language accessibility and highlight an important area for future improvement.

While the overall response to digital storytelling tools was highly positive, several visitors expressed critical reflections regarding the design, accessibility, and content integration of the technologies. These insights highlight important limitations that can inform future improvements. One recurring theme was the lack of personalization or adaptability in the content delivery. As one visitor at Felix Romuliana noted: *The video felt generic—like it could be used anywhere, not just here. I wanted more about this place's specific history and less abstract narration.*

Language limitations were also frequently mentioned, especially by international tourists. As one non-Serbian speaker explained, *"Some signs and videos had English subtitles, but not all. It was frustrating not to fully understand everything when the visuals seemed so promising."* In terms of technological performance, a few users experienced usability issues, such as lagging apps or difficult navigation. A visitor at Kalemegdan commented: *The AR app looked cool, but it crashed twice. I gave up eventually—it took me out of the experience.* Others noted inconsistent internet connectivity as a barrier to accessing certain features, particularly at more remote sites like Mokra Gora. Finally, a few participants raised concerns about screen fatigue and distraction, suggesting that excessive digital input sometimes

detracted from the physical site. One respondent stated, *"I felt like I was looking at my phone too much and not at the fortress. I had to remind myself to put the device away and just look around."* Such comments resonate with recent critiques about the risk of digital overexposure undermining authenticity and mindfulness in heritage tourism.

DISCUSSION AND CONCLUSION

The results of this study confirm and extend previous findings on the role of digital tools in enhancing cultural heritage tourism. Consistent with earlier research (e.g., Di Pietro et al., 2016; Tussyadiah, 2020), the digital tools implemented across the three Serbian heritage sites significantly contributed to visitor satisfaction, particularly through improved interpretive depth and emotional resonance. This aligns with the findings of Yoo & Yu (2024), who showed that multimedia storytelling enhances perceived value and enjoyment in cultural experiences.

The engagement results also reflect patterns observed in prior studies, notably Hollebeek et al. (2014), who emphasized the multidimensional nature of engagement—including emotional, cognitive, and behavioral facets. Our findings show strong emotional and cognitive engagement, particularly among younger and first-time visitors, which supports Li et al. (2025)'s conclusion that AR narratives are particularly impactful for those with limited prior knowledge. Educational outcomes were also positively evaluated, resonating with the work of Shahab et al. (2023) and Packer & Ballantyne (2002), who noted that structured digital narratives facilitate deeper knowledge acquisition. However, this study adds nuance by showing that higher-educated visitors reported stronger perceived learning effects, suggesting a need to consider differentiated content strategies for diverse audiences. Finally, ease of use was generally rated positively but showed variation by age, in line with findings by Park & Lee (2022). Older visitors sometimes reported difficulties with navigation and accessibility, highlighting ongoing challenges in digital inclusivity—an area that has been underemphasized in some earlier studies focusing predominantly on tech-literate populations.

This research contributes to the expanding theoretical discourse on digital engagement in heritage tourism by demonstrating the value of an integrated, multi-dimensional evaluation framework. By jointly analyzing satisfaction, engagement, educational impact, and usability, the study bridges fragmented research streams and supports calls for more holistic models (Mariani et al., 2022; Liu & Lin, 2023). It also reinforces experiential learning theories and digital storytelling frameworks, confirming that digital tools not only convey historical content but also stimulate emotional and cognitive processing. Furthermore, the demographic findings underscore the importance of audience-centered digital heritage theory, suggesting that personalization and accessibility are critical in achieving equitable interpretive outcomes.

The study has several practical implications for heritage site managers and digital tool developers. First, results indicate that storytelling formats—especially when supported by AR and video—are particularly effective in enhancing emotional engagement and visitor memory. Practitioners should therefore prioritize narrative-driven content design, with attention to emotional tone, site specificity, and contextual relevance. Second, the variation in usability across age groups calls for more inclusive design features. These may include clearer visual navigation, multilingual options, and offline availability to address internet limitations. Additionally, tailored content for different visitor types (e.g., first-time vs. repeat, young vs. older) can enhance cognitive engagement and perceived educational value. Heritage sites in less internationally recognized regions, such as those in Serbia, can leverage these findings to enrich visitor experiences and differentiate themselves in the global tourism landscape, while aligning with broader digital transformation strategies.

While this study provides valuable insights into visitor experiences with digital tools at cultural heritage sites, it is not without limitations. The research was limited to three Serbian heritage locations, which, although contextually rich, may not reflect broader patterns in different cultural or geographic settings. Moreover, the cross-sectional nature of the study does not allow for an understanding of long-term impacts, such as knowledge retention or changes in visitor behavior over time. Future research should therefore consider cross-cultural comparisons to explore whether digital storytelling and interpretive technologies produce similar effects across diverse heritage contexts. Longitudinal studies would be particularly useful in examining how digital experiences influence repeat visitation, word-of-mouth recommendation, or deeper educational engagement. There is also a need to assess the potential of emerging technologies—such as AI-driven or adaptive interpretation systems—that could offer more personalized and inclusive visitor experiences. Finally, future studies should evaluate the operational and financial sustainability of implementing digital tools, especially in smaller or less-funded heritage sites, to ensure that digital transformation efforts are both impactful and scalable.

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