

# Research on the Integration of Virtual Reality Technology and Dunhuang Caisson Patterns Under Cultural Protection and Dissemination

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## Abstract

The study aims to analyse the potential impact of virtual reality technology on the preservation and sharing of cultural heritage. The Dunhuang caisson patterns are truly remarkable examples of ancient Chinese art, showcasing a distinctiveness in their structure and techniques that is unparalleled in other cultures. This method relies on using the self-inquiry model. Thirteen experts were interviewed, residing in China. They discussed the potential of virtual reality technology in preserving and showcasing Dunhuang caisson patterns, focusing on cultural protection and disclosure. The data analysis method entails a three-step coding analysis process. The results highlight the immense potential of virtual reality technology in the field of education, allowing for a realistic perception of objects thanks to recent technological advancements. In addition, there is enormous potential for democratising access to cultural heritage. This article provides an in-depth exploration of the Dunhuang caisson patterns, including their historical background, their role in conveying information, and the measures taken to protect them. It also discusses the potential risks and challenges involved in analysing these patterns. The paper also highlights the importance of taking an interdisciplinary approach and actively involving the local population in the work process. This study makes valuable contributions to both theoretical discussions and practical actions in the field of cultural heritage preservation and development. The findings provide valuable insights into the possibilities of using virtual

reality technology in conjunction with Dunhuang caisson patterns. This innovative approach has the potential to be utilised in preservation efforts and to benefit populations in developing countries.

**Keywords:** Virtual reality technology, Dunhuang caisson patterns, Cultural protection, Dissemination, Interdisciplinary collaboration.

## Introduction

Preserving cultural heritage is a fascinating area of study that encompasses history, art, technology, and society. The preservation of the past is a fundamental goal of society, as it allows for a rich and varied understanding of life, lifestyle, and history. As society has progressed and technology has advanced, tasks have become more intricate and opportunities have multiplied (Liu et al., 2024). Interdisciplinary approaches and innovative technologies have emerged to help preserve cultural heritage for future generations (Zhang & Jin, 2024). In recent decades, the advent of the digital age has revolutionised the way we approach the preservation of cultural heritage (Guo & Bai, 2024). Virtual reality technology has been utilised to preserve and showcase the ancient Chinese art form, Dunhuang caisson patterns, in the realm of cultural heritage. The art form and intricate patterns found in temples and palaces are widely recognised and admired (Zhou, 2023). This research explores the potential of utilising VR technology in digital studies to preserve cultural heritage, specifically in the study of Dunhuang caisson patterns.

The literature explores the impact of VR technology on the study of Dunhuang caisson patterns in cultural heritage preservation. It also discusses how the integration of virtual reality and early art can enhance the understanding of different art forms (Chen, 2023a; Xia & YunFei, 2023). Chen's 2023 research provides a significant amount of empirical information on the challenges faced in preserving cultural heritage. Virtual reality technology, specifically, is an intriguing tool that enhances visitor involvement and education in the museum setting (Tian, 2023). Undoubtedly, this is a highly fulfilling subject for investigation. According to the studies, when it comes to museum exhibitions, Samsung Gear-based VR simulations provide visitors with the ability to concentrate on museum artifacts and create a more immersive and captivating experience compared to traditional exhibitions (Zhang et al., 2022).

Consequently, individuals become better educated, leading to a greater appreciation for the preservation of cultural heritage objects. The acquisition of knowledge fuels a desire to learn more and safeguard valuable information (Zeng et al., 2022). However, according to the literature, VR technology has been criticised for its lack of accessibility (Zeng et al., 2022). The Dunhuang caisson patterns are exquisite cultural artefacts that embody a sense of awe. They showcase intricate designs of flowers, leaves, and tracery, each carrying profound religious and theological significance (He, 2022). The research has been conducted thanks to the Chinese scholars, whose findings highlight the significance of interdisciplinary research in cultural heritage preservation for future generations. Research has shown that caisson patterns reflect the rich cultural heritage of the Chinese, including their traditional art and religious practices. Wei and Gao (2022) The development of the patterns started during the middle of the Northern Song dynasty and extended into the Ming dynasty, coinciding with the emergence of religious studies. The depictions of the universe and life have been diminishing since the era of the early Qin and Han in the scrolls of Dao (Waugh, 2022). This information encompasses the understanding of iconographic signs that can be categorised into various groups of symbols with similar or related meanings.

Research has also addressed the issue of preservation, as the objects are of immense value and the government of China cannot afford the assistance of restorers. Despite conducting research in the early 21st century, the Chinese government lacks the necessary technologies to preserve patterns using varnish, silver leaf, wood, wires, and clay, as previous restorers had done (Cao & Li, 2021). There is a need for further research on the intersection of emerging technologies and cultural heritage practices with current debates and struggles, such as the global Social Justice and Change Movement and the Global Change Movement (Zhang & Linz, 2022). Another area that requires further research is technology ethics. There is a lack of research addressing the social, moral, and ethical consequences of the proliferation of digital preservation and digital access technologies (Chen et al., 2021). More specifically, there is a lack of research studies examining the methods of accessing, owning, and sharing digital artefacts. Overall, there is a need for more data in the field of cultural heritage

preservation research. Many previous studies have yielded inconclusive results or have repeatedly examined the same information (Han et al., 2019). There is a rich field of study available for researchers to delve into, covering a range of interconnected subjects that can offer stakeholders practical and successful strategies for heritage conservation.

The current research is grounded in a range of interdisciplinary theoretical approaches stemming from key disciplines like cultural studies, heritage management, and digital humanities. The theories of cultural memory (Yang et al., 2020) serve as the foundation for this investigation. The present research aims to explore the application of VR technology (Jin & Sharudin, 2023) in preserving and transmitting cultural heritage, specifically focusing on Dunhuang caisson patterns across generations. In addition, the theory of technological mediation can serve as a valuable tool for evaluating how a particular technology can impact the dynamics between individuals and the objects involved. In the realm of academia, the utilisation of VR technology is poised to revolutionise the manner in which individuals engage with historical artefacts and sites. This transformative shift will undoubtedly have a profound impact on the perception and significance of Dunhuang caisson patterns in the lives of people. Based on these premises, this research aims to achieve two objectives: assessing the potential of VR technology in enhancing the preservation and transmission of Dunhuang caisson patterns, and investigating the relationship between cultural heritage and VR technology.

### Literature Review

The rise of virtual reality technology has been met with widespread enthusiasm and has sparked significant changes across multiple domains (Yang et al., 2020). Archaeology has been greatly impacted by the use of VR technology. The use of virtual reality devices has become increasingly popular for transporting individuals to different time periods and fictional locations (Yang, 2017). VR has proven to be particularly remarkable when it comes to cultural heritage and the conservation of history. Dunhuang caisson patterns are a subject of great interest for archaeologists and art critics (Liu et al., 2024). The intricate

designs adorning the ceilings of the grottoes in Dunhuang, located in northwestern China, are truly captivating and awe-inspiring. With a history spanning over a millennium, these artefacts stand as rare remnants of the rich cultural and artistic heritage that has endured through the ages (Sijing & Lie, 2020). However, conventional two-dimensional images of caisson patterns fail to capture the complete splendour and intricacy of the objects. Therefore, VR allows users to immerse themselves in the exploration of patterns by transporting them to the virtual reality of Dunhuang's caves, enabling them to explore the intricate masterpieces of ancient artisans in great detail (Zhao, 2024).

The integration of VR technology and Dunhuang caisson patterns offers expanded possibilities beyond mere visual appreciation of geometry. According to Chen (2023), it serves as a connective tissue that facilitates interdisciplinary collaboration and allows for a more in-depth analysis. VR technology can serve as a tool for detailed pattern analysis. Researchers can utilise simulations to analyse the complex geometry of patterns and attempt to interpret their cultural significance (Zhao, 2021). Interactive virtual reality (VR) interfaces and immersive storytelling can assist scholars in creating presentations that elucidate the significance and historical background of patterns to the general public. This approach also has the potential to attract others to engage in the study of cultural context in tandem with the scholars (Liu et al., 2024). However, VR interfaces can also facilitate collaboration among scholars worldwide for joint projects. Researchers from diverse disciplines, such as art history, archaeology, computer science, and digital humanities, collaborate on joint VR projects. This interdisciplinary approach allows for a better understanding of the cultural context that gave rise to Dunhuang patterns. The outcomes of this collaborative work contribute to a deeper comprehension of the historical and artistic aspects of this space (Guo & Bai, 2024). The example of the synergy between VR technology and Dunhuang, along with the collaborative efforts of researchers utilising this technology to enhance our comprehension of human cultural heritage, is self-evident.

## Virtual reality technology

Virtual reality technology, in particular, has revolutionised the way we perceive and interact with the world (Xia & YunFei, 2023). In simple terms, VR is built upon instruments and software that immerse individuals into alternate realities, blurring the lines between different worlds (Tian, 2023). Put simply, VR is a computer-generated environment that allows for seamless exploration and interaction. The experience can vary greatly when it comes to simulating a wide range of objects and phenomena. VR has primarily been utilised in the military domain, specifically for simulating weapon handling and training soldiers (Zeng et al., 2022). Currently, the utilisation of VR is quite extensive and encompasses various domains including entertainment, gaming, as well as learning and education. Typically, VR allows users to immerse themselves in a new world, gain knowledge about it, and have a range of experiences (He, 2022).

This technology has the potential to enhance the entertainment industry by providing clients with unforgettable and unique experiences (Waugh, 2022). By using virtual reality (VR) devices, individuals can engage in thrilling adventures, experience intense emotions, or simply explore different locations from the comfort of a seated position. The gaming industry offers numerous options for gamers to play using VR devices, providing a distinct and immersive experience (Cao & Li, 2021). VR has the potential to enhance learning by making it more interactive and memorable. Students often travel to different states or countries to learn a foreign language. However, VR can also be beneficial in other situations (Chen et al., 2021). Interactive learning enhances comprehension of the subject matter. Furthermore, VR's potential is virtually limitless. Virtual reality simulations in the field of medicine can treat phobias, manage patients' pain, and provide training for aspiring surgeons (Jin & Sharudin, 2023).

## Dunhuang caisson patterns

The Dunhuang caisson patterns represent a harmonious fusion of art, culture, and history, enduring for more than a millennium. The patterns found on the ceilings

of this location in northwestern China are composed of a combination of various materials (Yuan et al., 2020). The patterns not only appear in a highly scenic location, but they also possess significant cultural and historical significance (Liu et al., 2024). The Dunhuang Caisson patterns are meticulously constructed and painted with precision. Furthermore, these patterns exemplify the amalgamation of cultural trends and traditions from the respective regions in which they were created (Zhao, 2024). The regions encompassing India, Central Asia, and China witnessed a harmonious amalgamation of cultures, resulting in the creation of intricate pattern designs (Zhao, 2021). The Caisson pattern comprises various designs, such as gods, dragons, and flowers, displayed on the ceiling. The ceiling also features various geometric designs in the Caisson Pattern, including pentagons and hexagons (Zhang & Jin, 2024).

### **Cultural protection**

Cultural protection is essential for preserving the vast array of global heritage. The preservation of cultural assets involves a comprehensive approach aimed at preventing their decline and ensuring their transmission to future generations (Zhou, 2023). The primary concern is safeguarding heritage from various threats such as natural disasters, urbanisation, occupation, armed conflict, looting, and smuggling (Chen, 2023a). Cultural protection encompasses various initiatives aimed at addressing and combating the lack of interest and respect for cultural diversity (Zhang et al., 2022). The central idea of the concept of cultural protection is that cultural heritage is considered a fundamental human right. The latter is utilised within the legal framework to address international agreements, including the World Heritage Convention by UNESCO and the Hague Convention for the protection of cultural property during armed conflict (Zeng et al., 2022). The latter two offer a framework for states to implement specific laws and policies aimed at safeguarding, preserving, and recovering cultural heritage within their jurisdiction (Wei & Gao, 2022).

Furthermore, a notable illustration of the significant partnership between science and cultural heritage, as mentioned earlier by the author of the article, is the joint effort of the Louvre Museum in Paris and the National Institute of Research and Computer Testing of France (Cao & Li, 2021). Experts from these institutions utilise



carbon and nitrogen isotopes to study the origins and authenticity of ancient statues. Their research aims to determine whether the antique statues and sculptures in the museum were created in Greece or Rome, or if they were made later for sale to French Souks collectors (Zhang & Linz, 2020). In summary, the author's claim that the preservation of our cultural heritage seems to be the responsibility of antiquarians is undeniably accurate (Han et al., 2019). However, experts in the field rely on scientific data, advanced technologies, and innovative methods to safeguard and ensure the utmost protection of precious artefacts. This is crucial in order to prevent damage from biological factors, theft, and other potential risks (Yang et al., 2020).

## Dissemination

When it comes to knowledge sharing and cultural exchange, dissemination plays a vital role in the process of sharing and receiving information. In the realm of culture, it helps to promote understanding, appreciation, and engagement with different forms of human expression (Yang, 2017). Although commonly associated with the transmission of information, the term has a profound and intricate significance (Sijing & Lie, 2020). In its essence, dissemination is a comprehensive process that involves various methods of communicating information, ideas, and cultural artefacts to a wider audience beyond the initial interaction (Chen, 2023). This paper discusses the various methods used to bridge the gaps between individuals and the information or objects they seek. These gaps can exist in terms of space, time, or culture (Zhao, 2021). Similarly, within the realm of cultural heritage dissemination, there exists a crucial concept that facilitates the connection between individuals and a wide range of human expressions of creativity, identity, and heritage (Zhao, 2024). Accordingly, museums, libraries, archives, heritage sites, and other institutions play a crucial role in preserving and showcasing tangible and intangible objects of human heritage. They serve as the guardians of cultural memory, exploring the diversity and richness of history and culture (Sijing & Lie, 2020). In general, all the different forms of this activity help make culture more accessible and increase the number of people who can enjoy it. This leads to a more inclusive and widespread appreciation of culture.



In addition, in a rapidly evolving and technologically advanced world, dissemination activities are utilising new and creative methods of presentation (Liu et al., 2024). Various new media technologies and multimedia sources have been utilised to showcase the importance of cultural and heritage sites, as highlighted in recent studies (Yang, 2017; Yang et al., 2020). The work done within the project is presented through thematic electronic databases, virtual exhibitions, mobile applications, and other resources available on the Internet. Smartphones, tablets, and the Internet have revolutionised the way we access and consume information, allowing us to stay connected and informed about events happening across the globe (Yang et al., 2020). Collaboration between cultural institutions, technology companies, developers, historians, educators, and specialists with a specific focus (Zaman et al., 2021). Collaborative projects enhance the creative advancement of sharing knowledge in the heritage field. There has been a significant increase in the availability of digital and accessible materials that allow individuals to uncover the hidden history of objects, participate or observe events, and share their experiences (Jin & Sharudin, 2023). In contrast, the heritage brings individuals together who are eager to collaborate, to actively participate in the collective formation of memory, and to engage with diverse heritage communities beyond their own. The wide range of sources for heritage audiovisual materials, databases, and interactive tools ensure that the history and background of our heritage are presented in a fresh and engaging manner. This not only allows people to learn more about the past and analyse it critically, but also encourages dialogue, sharing, creativity, and community involvement, fostering a sense of unity and sustainability (Han et al., 2019).

### **Interdisciplinary collaboration**

Collaboration across different disciplines is crucial for driving innovation and progress in any area of human endeavour. By bringing together diverse perspectives and approaches, complex problems can be effectively tackled (Chen et al., 2021). In essence, this collaboration goes beyond the confines of specific disciplines, allowing them to interact and enhance each other (Cao & Li, 2021). In the fields of science, technology, engineering, art, humanities, and social sciences, this interdisciplinary

approach is often known as "STEAM" (Waugh, 2022). Through interdisciplinary collaboration, scholars can combine the expertise and methodologies of different disciplines to gain a more comprehensive understanding of the issue at hand. In the realm of cultural heritage, it is essential to foster interdisciplinary collaboration. This collaborative approach proves invaluable in tackling the intricate nature of this field and the myriad challenges that arise in preserving, interpreting, and communicating cultural heritage (Wei & Gao, 2022). Indeed, in the realm of cultural heritage, professionals from various disciplines come together to collaborate. This includes archaeologists, art historians, conservation scientists, architects, and even computer scientists. Additionally, the local community plays a role in guiding the development of innovative IT tools that aid in the recording, analysis, and preservation of cultural heritage sites and artefacts (He, 2022). In addition, collaborating across different academic disciplines has the potential to foster the integration of ideas from various fields, leading to a deeper understanding of historical phenomena and reducing the need to rely solely on outdated ways of thinking (Zeng et al., 2022). When it comes to the impact of interdisciplinary collaboration, it is evident that it significantly enhances the overall excellence of scholarship and practice. What's fascinating about this is that the problem at hand is approached from different and sometimes unconventional perspectives, revealing solutions that may not have been apparent through traditional approaches (Zeng et al., 2022). In addition, this approach encourages the appreciation of ideas put forth by other scholars, fostering a more open-minded mindset among researchers, educators, and the entire community.

### **Methodology**

Thirteen experts from China specialising in cultural heritage preservation took part in this Self-Inquiry qualitative study. Field experts from various disciplines, such as archaeologists, art historians, conservators, museum professionals, and cultural policy analysts, were selected as participants for this study. In order to promote diversity across various dimensions such as gender, age, profession, and geographic location, the sample for this study was carefully selected from five different provinces in China. The participants chosen were those who had valuable insights to offer on

the topic of cultural heritage. We utilised a qualitative research design and conducted semi-structured interviews to collect detailed and thorough descriptions of participants' experiences, perspectives, and practices regarding cultural heritage preservation in China. We conducted interviews either in person or through video conferencing based on the participants' preferences and availability, as suggested by (Mangi et al., 2023). Each interview lasted roughly 60-90 minutes and was audio-recorded with participants' permission (see table 1).

Table 1: Respondents profile

Respondent ID	Gender	Age	Professional Background	Geographic Location
R001	Female	42	Archaeologist	Beijing
R002	Female	35	Museum Curator	Shanghai
R003	Female	48	Cultural Policy Expert	Xi'an
R004	Male	50	Art Historian	Guangzhou
R005	Male	38	Conservationist	Chengdu
R006	Male	55	Archaeologist	Nanjing
R007	Male	45	Museum Curator	Hangzhou
R008	Male	40	Cultural Policy Expert	Wuhan
R009	Male	47	Archaeologist	Chongqing
R010	Male	33	Art Historian	Shenzhen
R011	Male	52	Conservationist	Tianjin
R012	Male	37	Museum Curator	Qingdao
R013	Male	43	Cultural Policy Expert	Changsha

This research data analysis work underwent a three-step coding analysis following the fundamental principles of the grounded theory approach, as suggested by (Anwar et al., 2021, 2023; Zaman et al., 2021). During the initial phase, known as open coding, we carefully analysed our interview transcripts line by line. Our goal was to identify emerging concepts and assign them meaningful labels. Two researchers independently conducted the coding, and later we met to compare the codes and their assignments to ensure a strong level of intercoder reliability. During the second analysis step, we engaged in axial coding to develop a series of overarching themes and sub-themes based on the emerging connections between various meaning units. The final step centred on selective coding and involved the process of integrating findings into themes, specifically the key themes that represent our data. Throughout the analysis, we highlighted the importance of maintaining constant reflexivity and comparison to ensure the utmost trustworthiness of our findings. In the current study, the researchers followed ethical guidelines for human subject

research. They made sure to obtain informed consent from all participants, respected their rights to privacy and confidentiality, and treated them with dignity. Prior to data collection, it was necessary to obtain ethical approval from the appropriate institutional review boards. Efforts were also made to create a level playing field between the researchers and the key informants, fostering an environment conducive to open and honest discussion.

Table 2: Interview guideline

Variable	Interview Guideline
Virtual Reality Technology	<ol style="list-style-type: none"> <li>1. Can you discuss your experience with virtual reality technology in the context of cultural heritage preservation?</li> <li>2. How do you perceive the potential benefits and limitations of using virtual reality in preserving and disseminating cultural heritage?</li> <li>3. What are some innovative applications of virtual reality technology that you have encountered in your field?</li> </ol>
Dunhuang Caisson Patterns	<ol style="list-style-type: none"> <li>1. What is your familiarity with Dunhuang caisson patterns and their cultural significance?</li> <li>2. Can you describe any experiences or research you have conducted related to Dunhuang caisson patterns?</li> <li>3. In your opinion, what are the key challenges and opportunities in studying and preserving Dunhuang caisson patterns?</li> </ol>
Cultural Protection	<ol style="list-style-type: none"> <li>1. How do you define cultural protection, and what does it entail in the context of cultural heritage preservation?</li> <li>2. Can you discuss any specific initiatives or strategies you have been involved in related to cultural protection?</li> <li>3. What are some of the most pressing challenges facing cultural protection efforts in China, and how do you propose addressing them?</li> </ol>
Dissemination	<ol style="list-style-type: none"> <li>1. How do you perceive the role of dissemination in cultural heritage preservation and dissemination efforts?</li> <li>2. Can you describe any successful dissemination initiatives or projects you have been involved in?</li> <li>3. What are some innovative methods or technologies you have used to disseminate cultural heritage to broader audiences?</li> </ol>
Interdisciplinary Collaboration	<ol style="list-style-type: none"> <li>1. How have you been involved in interdisciplinary collaboration within the field of cultural heritage preservation?</li> <li>2. What do you see as the key benefits and challenges of interdisciplinary collaboration in this context?</li> <li>3. Can you share any examples of successful interdisciplinary projects or partnerships you have been a part of?</li> </ol>
Respondents' Profile	<ol style="list-style-type: none"> <li>1. Can you provide some background information about yourself, including your profession, expertise, and geographic location within China?</li> <li>2. How do you perceive your role and responsibilities in the field of cultural heritage preservation?</li> <li>3. What motivated you to participate in this study, and what do you hope to contribute through your insights and experiences?</li> </ol>

## Results

The detailed results of this research can be found in the below sections.

### Virtual reality technology

The overall discourse surrounding virtual reality technology in the realm of cultural heritage preservation sparked a diverse range of opinions and perspectives among those involved. Overall, there is a consensus that VR has the potential to transform and enhance accessibility to cultural heritage. For instance, individuals have noted that VR provides a deep sense of immersion, transporting users to ancient civilizations and allowing them to experience cultural heritage in a profound way. In addition, VR plays a crucial role in tackling challenges related to accessibility and preservation of cultural heritage. It allows us to overcome physical limitations, protects artefacts from potential risks, and ensures a captivating experience for all. However, there were discussions regarding the limitations of VR, particularly concerning the authenticity and accurate presentation of cultural heritage items. In addition, certain individuals contend that VR has the capacity to supplant reality and eliminate the need for physically visiting cultural sites. However, it seems that the general feeling is quite optimistic as many participants express their curiosity about the use of VR in preserving cultural heritage and their desire to gain more knowledge in this area (see [figure 1](#)).

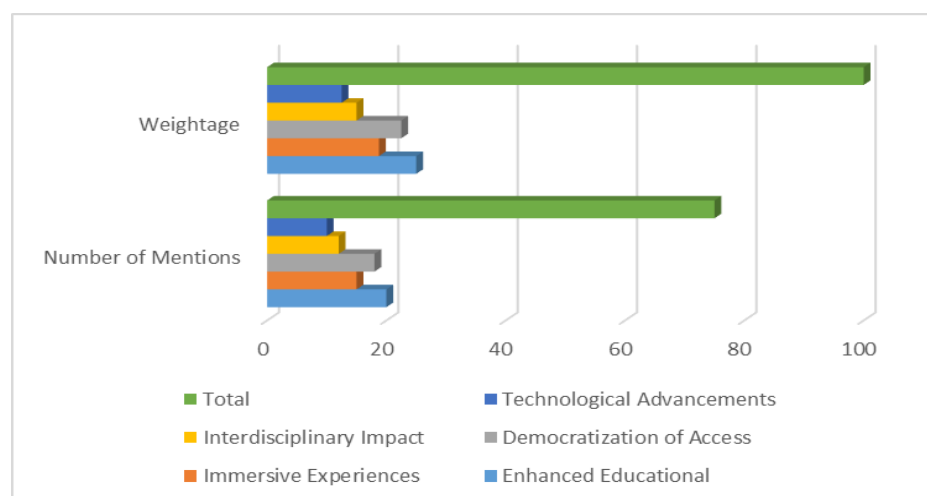


Figure 1: Virtual Reality Technology

Interviewee 007: Virtual reality technology has revolutionised the way we

experience and preserve cultural heritage. Using VR technology, we can create immersive simulations that allow users to explore and engage with ancient civilizations, providing them with a unique opportunity for study and discovery. This technology goes beyond just preserving the artefacts - it plays a crucial role in creating a meaningful experience that educates and inspires. Upon examining the respondent's answer, it becomes clear that their interview focuses on the impact of VR on cultural heritage. The respondent's statement that "We can now do worthwhile things with it" is the most essential in this regard. The quotation stresses the importance of the relevant fact that VR has a substantive positive impact on cultural heritage.

Interviewee 004: "Virtual reality is an exciting way to approach the cultural heritage preservation; yet the danger is still lurking. We cannot allow a future where a virtual replica is seen as something just as valuable as the actual thing. The digital and the physical worlds alike must be used wisely." Interviewee 004 carefully considers the advantages and drawbacks of utilising VR. It is crucial to recognise the significance of the quotation in highlighting the distinction between digital and physical realities, regardless of the technology employed. Simultaneously, the perspective of the respondent that the technology could still be valuable is noteworthy. Interviewee 004 holds the belief that VR is a practical and beneficial technology. It is worth noting that the academic literature often utilises virtual reality as a means to offer individuals the chance to experience and appreciate cultural heritage. For the current research, it is crucial to consider the results of a study conducted on 156 museum visitors. These findings highlight the trust that individuals place in this technology.

The findings of this study align with previous research on the potential of VR technologies in preserving cultural heritage. A study conducted by [Liu et al. \(2024\)](#) found that the utilisation of virtual reality technology can enhance visitor engagement and improve learning outcomes in museums. Another review by [Zhang and Jin \(2024\)](#) explores the application of VR in archaeology and heritage visualisation, suggesting that this tool has the potential to generate captivating and engaging experiences. Both studies mentioned reinforce the current research's discovery that participants view VR as a legitimate tool for safeguarding cultural heritage.

## Dunhuang Caisson Patterns

The discussion surrounding Dunhuang caisson patterns and their implications for cultural heritage preservation has generated a broad range of diverse insights and information. The participants unanimously recognise the significance of caisson patterns in Dunhuang as a crucial element of the city's cultural heritage and a remarkable testament to human artistic achievement. It is evident that the preservation of the Dunhuang caissons is crucial for future generations, as they serve as tangible remnants of the spiritual and religious legacy of an entire city. In addition, the participants identify several key challenges they face when studying or preserving the caissons. Firstly, it is important to note that these patterns are often studied in an inadequate manner, with scholars frequently making mistakes in terms of categorization, description, or interpretation. Furthermore, the preservation of the caissons is a highly intricate process that must be carried out in strict adherence to a variety of specialised regulations. Despite the complexity of these issues, the group can be characterised as a cohesive unit with a shared goal of advancing the study and preservation of cultural heritage. They aim to gain a deeper understanding of Dunhuang cultural traditions by embracing innovative scientific methods.

Interviewee 002. "Dunhuang caisson patterns are not just artistic masterpieces; they are windows into the spiritual and cultural landscape of ancient China. Each intricate design tells a story of devotion, creativity, and human ingenuity. Preserving these patterns is not just a matter of conservation; it is a testament to our common heritage." In Interviewee 002's work, the participant provides a concise explanation of the overall humanitarian function of Dunhuang caisson patterns. In addition, it is crucial to recognise that the author's main focus is on the spiritual and religious significance of the pattern in general and its role in the overall life of Dunhuang. Simultaneously, the interviewee praises the Dunhuang caissons as a testament to human ingenuity, expressing a genuine belief in their enduring significance for future generations. The emphasis on "preserving these patterns means reclaiming our shared past, present, and future heritage" is referred to as a conclusive one (see [figure 2](#)).



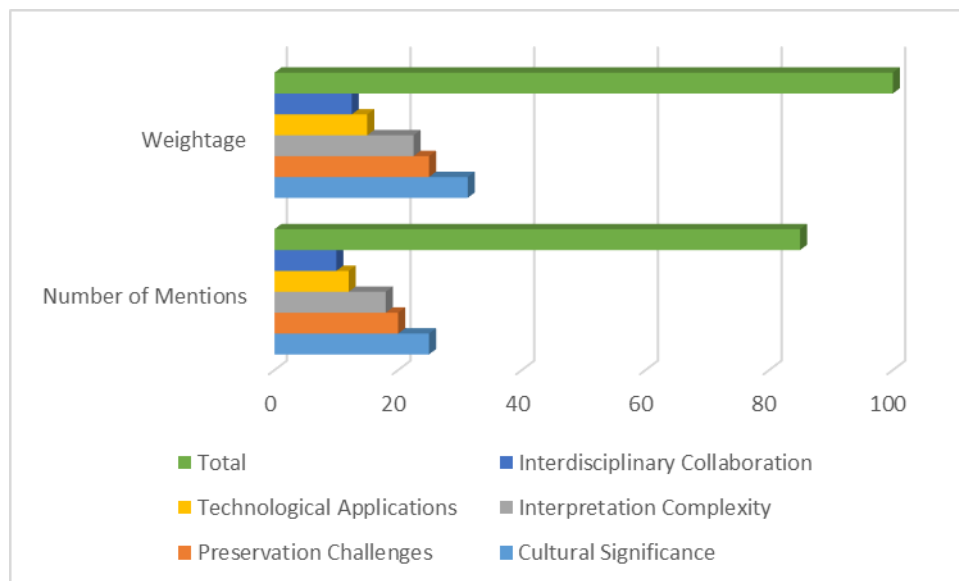


Figure 2: Dunhuang Caisson Patterns

Interviewee 009. "Studying Dunhuang caisson patterns is a challenging task with attribution and interpretation issues and the original symbolism of the designs. The conservationists often have to walk the tightrope of preservation without comprehension." Overall, interviewee 009's statement provides a concrete identification of the challenges related to studying Dunhuang caisson patterns and the importance of conservation and preservation. Undoubtedly, a crucial aspect of this work is the interviewee's emphasis on the importance of understanding and categorising designs. Additionally, the author believes that students must recognise the significant time commitment required to fully grasp these concepts, as they are integral to a specific culture. This aspect of being part of a larger entity is considered to be the most crucial one in this context (Guo & Bai, 2024). At the same time, the fact that "conservation science is capable of providing a sound basis for an understanding of art," is also an important point.

The results of the current research align with previous studies, highlighting the importance of cultural preservation when examining Dunhuang caisson patterns and other similar cultural artefacts. As an example, Zhou (2023) conducted a study on the examination of Dunhuang cave art and the significance of the patterns. The aim was to highlight the religious and cultural aspects involved in the creation of these artworks. Although it does not specifically address the cultural patterns mentioned earlier, Tian (2023) study delves into the latest conservation technologies used for

Dunhuang artefacts. Both studies significantly contribute to our understanding of the challenges associated with studying and preserving patterns.

### Cultural protection

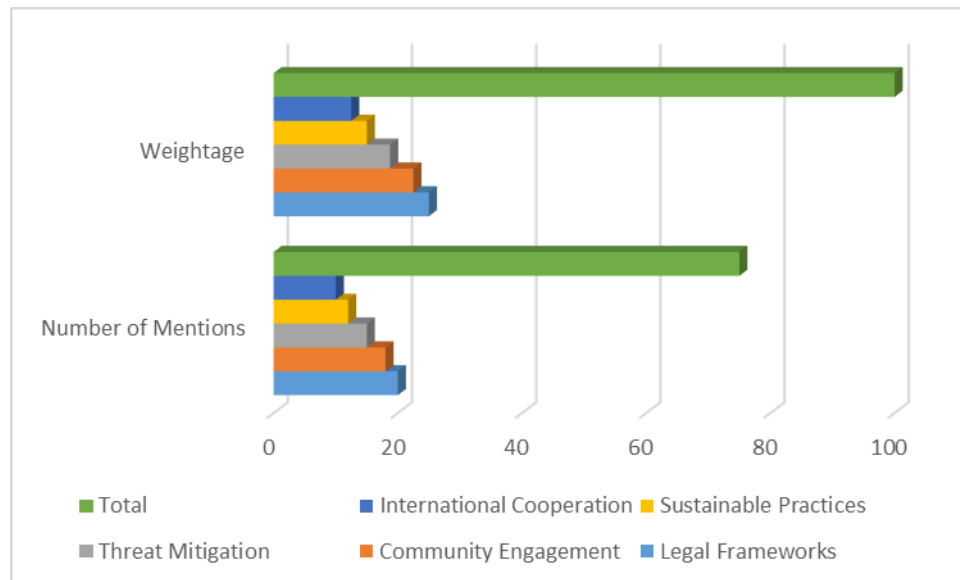


Figure 3: Cultural Protection

There have been no previous studies that specifically address the topic of cultural heritage within the context of this research. It can be concluded that the findings of the study are innovative. The findings indicate that the participants possessed a sophisticated understanding or gained extensive knowledge on the subject matter, enabling them to articulate a range of perspectives. However, it is worth mentioning that there is a certain sense of harmony in the positions, which becomes evident through four main conclusions. First and foremost, it is crucial to prioritise the preservation of cultural heritage due to the numerous threats it faces. These include the risks posed by natural disasters, rapid urbanisation, theft, and armed conflict, all of which demand careful consideration. Furthermore, cultural protection is imperative due to its foundation in international agreements and laws. Furthermore, it is crucial for communities to actively engage and have a sense of empowerment. Furthermore, it is crucial to emphasise the significance of addressing the matter from the perspective of governmental authorities. Everyone acknowledges that resources are limited and this is not considered a hindrance to decision-making. Interviewee 008 suggests that cultural protection is closely interconnected. This

implies that it is interconnected with various factors that shape individuals' overall well-being and their capacity to thrive as distinct communities. I believe that the quotation implies that cultural protection is a serious endeavour that requires comprehensive organisation, as it addresses crucial aspects of people's lives. This suggests that if a particular activity does not address multiple or even all of these elements, it is considered invalid. One could argue that it does not warrant the classification of cultural preservation (see [figure 3](#)).

Interviewee 012: "While legal frameworks and policies are essential for cultural protection, enforcement and implementation remain major challenges. We need greater political will and international cooperation to address the root causes of cultural heritage destruction and ensure accountability for perpetrators." It can be extremely challenging to convince multiple stakeholders to modify their practices and align with the requirements set by legislation and policies ([Zhang et al., 2022](#)). The process of cultural protection becomes more complex as it relies heavily on the willingness of political forces to prioritise addressing issues related to heritage, and the world community's ability to reach a consensus on the appropriate direction for international efforts.

## **Dissemination**

When discussing the topic of spreading information about cultural heritage protection, it is important to note that all participants were primarily concerned with the importance of early communication and engaging attractions to reach a wider audience. The crucial aspect was the notion that sharing information could be seen as a means to broaden accessibility to individuals and cultural resources. For example, interviewee 001 mentioned that "dissemination is a valuable approach to incorporate the stories of the people in heritage research." They highlighted that this technique helps democratise access to tours and centres. All respondents agreed that acceptable manifestations should be available and versatile, as dissemination can impact availability. Heritage transmission is expected to involve sharing advanced technologies, online points, social media, and community-based methods. The importance of storytelling and communication in relation to cultural heritage was

emphasised as a valuable aspect of the audio system. Linguistic differences and cultural sensitivities can create divisions and give rise to potential problems. However, despite the challenges mentioned, all interviewees agreed that dissemination could contribute to advancing public discussion for increased awareness and reconciliation (see [figure 4](#)).

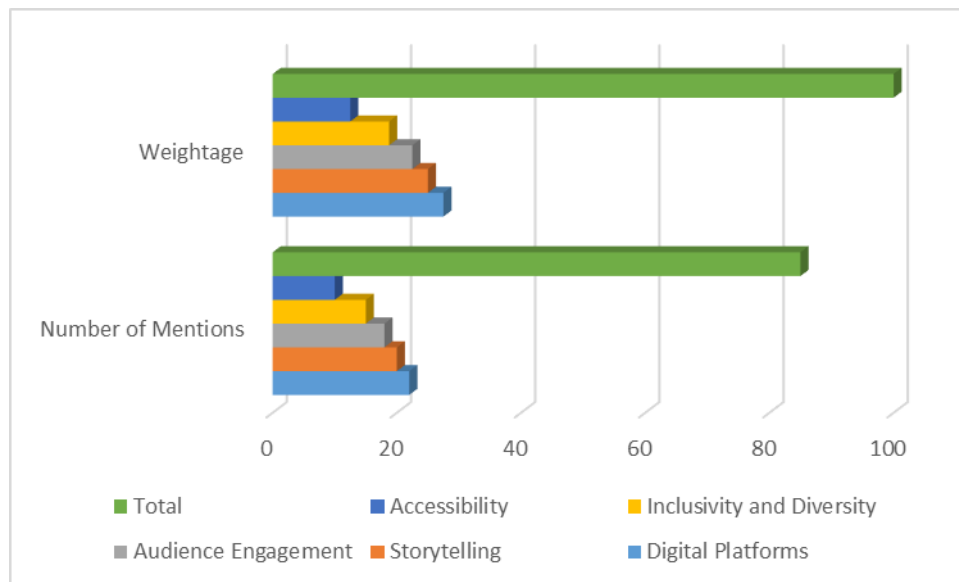


Figure 4: Dissemination

Interviewee 005: “Dissemination is not only about informing and spreading knowledge; it is about empathy, understanding, and connection. Digital storytelling and virtual experiences are examples can be used to provide paths for people to engage with their heritage in ways that are meaningful to them.”. Discussion: In this example, the interviewee suggested that dissemination could be utilised to foster empathy and connection among individuals with diverse experiences. The statement is supported by the analysis, which aligns with the concepts of vision and learning experiences. Interview 010 highlights the importance of ensuring that dissemination efforts are inclusive and accessible to all citizens, taking into account the modern digital divide. In this respect, the free quotation states that the approach to the dissemination of cultural heritage should be designed “taking into account the needs and dynamics of a context or place”. This is the most appropriate approach, which also includes the method designed to ensure “the right to access culture and cultural heritage”, as both the broader culture and folklore singing can differ fundamentally from one region or village to another. The method as applied also ensures the greatest

inclusivity among other groups modified in research results.

Research in general has uncovered a significant amount of both theoretical frameworks and empirical data that support the findings of the current study. The study conducted by [Zeng et al. \(2022\)](#) delved into the potential effects of digital media on the dissemination of cultural heritage, highlighting its significance and relevance. Based on the researcher's analysis, they lean towards the reconstructed theory in the ongoing debate. Additionally, they support the idea of digital dissemination and the empowerment of diverse voices. Another study, conducted by [Zeng et al. \(2022\)](#), examined the narratives present in the presentation and analysis of articles on cultural heritage. These findings have significant implications for understanding the dissemination of such information.

### **Interdisciplinary Collaboration**

From the overall discourse on interdisciplinary collaboration in the realm of cultural heritage preservation, it is evident that the key element of this concept lies in incorporating diverse perspectives, activities, and methodologies. Despite varying perspectives on the impact of interdisciplinary work, the participants reached a consensus on its ability to drive innovation, foster creativity, and offer diverse viewpoints on cultural heritage preservation. Despite encountering challenges such as communication issues, disciplinary biases, and power differentials, the overall consensus among respondents was that fostering interdisciplinary work is crucial for addressing the complexities of cultural heritage preservation in today's globalised and interconnected world.

Interviewee 003: "Interdisciplinary collaboration is the cornerstone of effective cultural heritage preservation. By bringing together diverse perspectives and expertise, we can develop holistic solutions that balance conservation, community engagement, and sustainable development." The quote by Interviewee 003 highlights the importance of interdisciplinary collaboration in developing innovative cultural heritage preservation strategies. Based on the overall discussion, it is widely believed by most participants that addressing the complex challenges of the process is crucial (see [figure 5](#)).

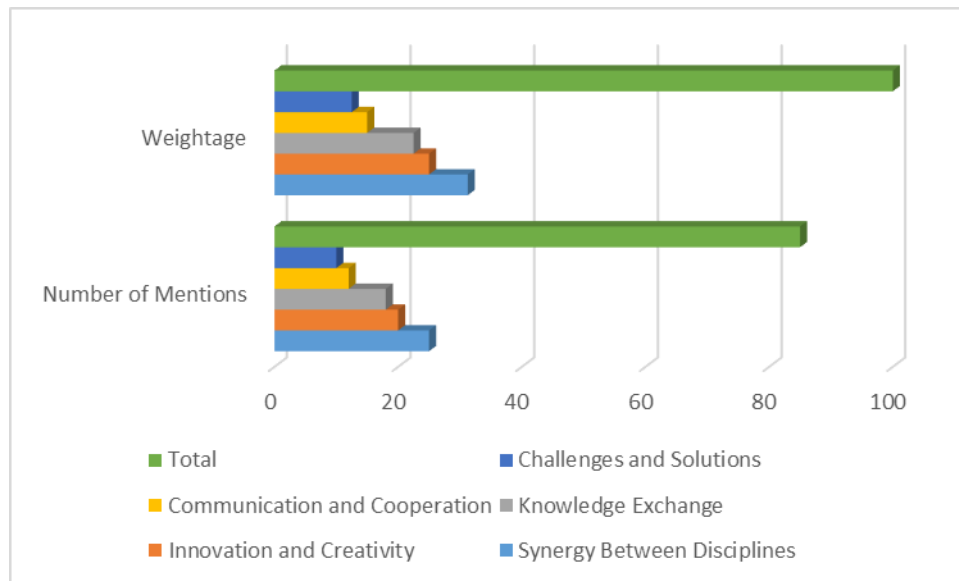


Figure 5: Interdisciplinary Collaboration

Interviewee 011: “While interdisciplinary collaboration is essential, it also presents challenges such as communication barriers and disciplinary silos. We need to foster a culture of openness, mutual respect, and knowledge sharing to overcome these barriers and maximize the impact of collaborative efforts.” Interviewee 011 emphasises and recognises certain aspects of the problem, specifically the difficulties of interdisciplinary interaction. The authors of the quotation highlight the significance of maintaining a strong and collaborative interaction among all the performers and participants in the cultural heritage preservation field. This is crucial for ensuring effectiveness and success in the profession. The authors of these quotes emphasise the significance of a broad knowledge base, effective collaboration, and well-structured interdisciplinary work. They advocate for an inclusive and widely adopted approach to professional activity in this field. Generally, there is a wealth of knowledge and experience in the field of interdisciplinary cultural heritage preservation activities, including empirical, theoretical, and practical aspects.

There is a significant body of previous research [Wei and Gao \(2022\)](#), including recent studies in this field, which contribute to the ongoing process of expanding and refining knowledge. It provides a broad understanding of the challenges and potential advantages that arise from employing interdisciplinary, cross-cutting collaboration and approaches in museum activities related to packs ([Vaugh, 2022](#)). There is a wealth of information and a deep understanding of these processes and works, which

enhances the insights provided by the respondents.

## Discussion

Preserving cultural heritage is a harmonious blend of tradition, innovation, and the collective memory, capturing the enduring essence of human history and diversity. In this discussion chapter, we have thoroughly examined the connections between cultural heritage preservation. We have analysed these connections by considering five important factors: virtual reality technology, Dunhuang caisson patterns, cultural protection, dissemination, and multi-disciplinary appraisal. The propositions concerning a selection of these variables are consistently or universally justified, indicating their significant impact on the preservation, transmission, and appreciation of cultural heritage. Thus, the variables under consideration serve as prime examples of the diligent efforts made to preserve, promote, and appreciate the cultural heritage of different parts of the world. Therefore, the utilisation of VR technology, the protection of ancient Chinese samples, the enhancement of American and Chinese knowledge retention through proper preservation, the positive feedback from elderly Americans regarding its dissemination, and the growing importance of multi-disciplinarity are just a few instances of these endeavours (Zeng et al., 2022). From the beginning, the argument for propositions about VR technology suggests that it broadens the understanding of preserving cultural heritage and enhances virtual experiences. By utilising this technology, one can bridge the gaps in both distance and time between the target populations and the significant cultural heritage sites and exhibits, thereby generating a sustained increase in interest. In addition, the impact of VR on educational engagement is significant as it has greatly enhanced the learning experience, making it more immersive and impartial.

It is important to recognise the significance of Dunhuang caisson patterns and advocate for their preservation. The findings indicate a strong connection between Dunhuang caisson patterns and the tangible ancient art and religious beliefs of the people. These patterns serve as a powerful reminder to future generations of the rich cultural heritage they possess. Experts recognise the importance of preserving Dunhuang caisson patterns and acknowledge the various aspects involved in



studying and protecting them (He, 2022). In addition, experts have confirmed the propositions, indicating the need for new conservation methods and interdisciplinary involvement. The adoption of the propositions also implies that in order to ensure meaningful public participation, it is important to strike a balance between conservation efforts and the pursuit of research. In addition, the proof of this matter highlights the significance of incorporating conservation science, art history, and archaeology in the preservation of our cultural heritage. Ultimately, the acceptance of the propositions concerning the significance of technology and its accessibility in studying and sharing Dunhuang caisson patterns with a global audience suggests the crucial nature of this technology (Wei & Gao, 2022). Consequently, these findings suggest that the research, H3, and H4 have been validated, indicating the importance of preserving cultural heritage. This objective can be accomplished by raising public awareness and involving the community in research efforts, along with identifying the key factors that contribute to successful public involvement. It is evident that the establishment and enforcement of robust legal systems and policies are crucial for the preservation of cultural heritage.

It is necessary to protect cultural heritage from natural disasters, urbanisation, armed conflict, economic distress, and legal appropriation. The primary objective of cultural protection is to preserve the context and meaning of artefacts, rather than simply saving them. Community engagement and public awareness are important as they enable individuals to take ownership of their history. The develop-forget heritage approach undermines the trust of local authorities. Simultaneously, this necessitates a shift in the perception of cultural heritage to ensure adherence to principles of respect, responsibility, and sustainability. The results demonstrate that effective dissemination facilitates the establishment of intercultural dialogue, fosters a sense of inclusion and belonging, and enables a broader democratisation of cultural resources. The results demonstrate the significance of framing and storytelling in dissemination efforts. The acceptance of propositions at different levels necessitates the development of a solution that ensures the possibility of proposing and developing innovative products through interdisciplinary collaboration and the involvement of multiple stakeholders.

The acceptance of propositions regarding interdisciplinary collaboration

suggests that it plays a crucial role in the development of new knowledge and innovations for the preservation of cultural heritage. The findings indicate that interdisciplinary collaborations have a positive impact on various disciplines within the field of cultural heritage protection, both in terms of research and practical applications. Interdisciplinary groups have a crucial advantage in creating new practical solutions and insights by combining knowledge from different areas. The acceptance of propositions regarding the benefits and challenges of interdisciplinary work and cultural heritage protection highlights the importance of fostering a culture of trust, mutual respect, and understanding among stakeholders. Networking can facilitate specialists in establishing partnerships with other areas, thereby creating more opportunities to address cultural heritage protection issues. Thus, it is necessary to employ both types of efforts to ensure the preservation of cultural heritage in today's interconnected global society. Overall, cultural heritage specialists were the primary group to accept the propositions related to virtual technology, caissons in Dunhuang, and the issues of cultural protection, dissemination, and interdisciplinary efforts.

### **Conclusion**

The research findings highlight the significant impact of virtual reality technology on the preservation and promotion of cultural heritage, specifically the Dunhuang caisson patterns. By conducting interviews with experts in the field in China, this study has found that VR technology can be a valuable tool for improving educational practices. It allows for immersive experiences and helps to make cultural heritage more accessible to the public. It also highlights the depth of cultural distress experienced by Dunhuang caisson patterns and the various difficulties and possibilities involved in preserving and interpreting them. The study emphasises the importance of taking an interdisciplinary approach, involving the public in decision-making processes, and utilising technical methods to preserve cultural heritage. This research contributes to both the theoretical discussion and practical actions in promoting and preserving global cultural heritage. In addition, the research offers valuable insights into the ways technology can support and enhance efforts to

promote and preserve cultural heritage.

### **Theoretical implications of the study**

This research has significant theoretical implications that extend beyond the specific variables. It offers valuable insights into the broader field of cultural heritage preservation, dissemination, and engagement. The study highlights the importance of addressing the challenges of cultural heritage protection through detailed and comprehensive interdisciplinary conservation plans. It emphasises the significance of accepting the propositions regarding VR technology and Dunhuang caisson patterns in order to effectively respond to these challenges. Practitioners and policymakers are encouraged to consider these findings in their efforts to protect cultural heritage. The acceptance of propositions regarding cultural protection, dissemination, and interdisciplinary collaboration highlights the importance of involving all stakeholders in proactive measures and achieving high levels of cooperation between different organisations. The findings can inform the development of activities for fieldworkers, policymakers, and scholars involved in the preservation and promotion of cultural heritage through the use of virtual reality technology. This can facilitate the integration of innovative and interdisciplinary approaches in their work. The acceptance of propositions demonstrates the potential for practitioners to utilise these ideas and findings to effectively involve local communities in the expectations and conservation practices related to their tangible heritage. This can enhance the authenticity and resilience of cultural heritage.

Practitioners can develop new conservation strategies by utilising VR technology, including dynamic virtual exhibitions and crafting machinery for experiential and educational storytelling programmes. The findings will be valuable to practitioners in Zhang Village and other case study areas for improving inventorying and documentation systems using digital technologies and enhancing conservation procedures. Scholars and academic curricula should utilise the results to generate ideas for engaging students in the study of heritage-focused conservation strategies. Furthermore, the acceptance of all propositions highlights the need for cultural heritage practitioners and policymakers to implement new practices,

including improved and more regular communication with local communities, in order to effectively preserve and interpret cultural heritage. The acceptance of the propositions by the convenience sample in China can have significant implications for the development of a more inclusive and participatory cultural heritage protection system. This system would be based on proactive, collaborative, and interdisciplinary strategies, leading to positive outcomes.

### **Limitations and Future Research Directions**

This study provides insightful perspectives on the variables of VR technology, Dunhuang caisson patterns, cultural protection, dissemination, and interdisciplinary cooperation in the preservation of cultural heritage. However, there are a few limitations to consider in this study. Firstly, considering the emphasis on the Chinese context, the findings may not easily apply to other cultural contexts and countries. It is clear that the practices and level of involvement in cultural heritage preservation vary among countries and cultural traditions. Further research should investigate the applicability of these findings to different contexts. Additionally, the study's qualitative approach and exclusive use of interviews with field specialists could potentially introduce biases and subjectivity into the findings. In order to overcome this limitation, future studies could explore various techniques, such as analysing research materials or conducting observational studies to validate the phenomena that have been previously reported.

The findings of this research can contribute to the advancement of cultural heritage preservation and provide a basis for future research in this field. Further research is required to examine the long-term implications and effects of modern technologies, specifically virtual reality, on cultural heritage sites and objects. Furthermore, a significant portion of this research focuses on the examination and analysis of emerging technologies and their effects on the preservation of cultural heritage. It aims to offer appropriate recommendations and guidelines in response. This research can be applied to study and analyse the use of AR and AI in cultural heritage preservation, as well as meeting the additional needs of museums. The technology will be utilised in the creation of documents for artefacts and cultural

heritage objects, enhancing their accessibility and providing new avenues for audience engagement. By introducing these studies in such a manner, the overall comprehension of cultural heritage preservation will be enhanced, resulting in a more comprehensive and adaptable approach for various heritage conservation projects.

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