

The Next Generation Internet Technology Applied to Cultural Heritage Conservation

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Abstract: This article discusses the application of utilising next-generation Internet technologies to enhance the preservation of cultural heritage. It examines potential uses such as digital archiving, secure transactions of cultural assets, and Web 3.0 technology as a tool in the digital film and television production industry, with a particular focus on visualised methods. By exploring these applications, the article underscores the transformative potential of next-generation Internet technologies in addressing the challenges of cultural conservation in the digital age. The discussion highlights how decentralised frameworks, blockchain technology, and enhanced data ownership can revolutionise the management, protection, and engagement with cultural heritage, offering innovative solutions to technical and ethical issues. Through this analysis, the article aims to provide a comprehensive understanding of the role Web 3.0 can play in safeguarding our shared cultural legacy for future generations.

Keywords: Next-Generation Internet Technologies; Digital Age; Cultural Heritage

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1. Introduction

Recent advancements in next-generation Internet technologies, such as Web 3.0 technology, are significantly transforming our daily lives in unprecedented ways. With its continuous enhancements in machine learning, natural language processing, and computer vision, AI drives myriad innovations across various sectors. AI is revolutionising diagnostics, personalised treatment plans, and patient monitoring in healthcare. Advanced algorithms can now accurately analyse medical images, predict patient outcomes, and even assist in surgical procedures, improving the quality of care and patient safety. Additionally, AI-powered applications such as intelligent virtual assistants and chatbots are becoming indispensable in our daily routines, streamlining tasks and providing instant support and information. These virtual assistants, like Siri, Alexa, and Google Assistant, leverage AI to understand and respond to human language, manage schedules, control smart home devices, and even offer personalised recommendations.

Web 3.0, the following internet iteration built on blockchain technology, reshapes online interactions. Unlike its predecessor, Web 2.0, which is dominated by centralised platforms, Web 3.0 emphasises decentralisation, giving users more control over their data and digital identities. Blockchain, the underlying technology of Web 3.0, ensures that data is stored securely, transparently, and immutable. This shift is particularly impactful in the realm of financial transactions. Cryptocurrencies like Bitcoin and Ethereum, which operate on blockchain technology, enable peer-to-peer transactions without intermediaries like banks, reducing transaction fees and increasing financial inclusion.

Furthermore, Web 3.0 also introduces the concept of digital ownership through Non-Fungible Tokens (NFTs). NFTs represent unique digital assets that can be bought, sold, and traded on blockchain platforms. This has opened new avenues for artists, musicians, and content creators to monetise their work and engage with their audiences directly. Moreover, Web 3 is fostering the growth of decentralised applications (dApps) that operate on blockchain networks, offering services ranging from decentralised finance (DeFi) to gaming and social media without relying on traditional intermediaries. As these technologies evolve, they promise to drive further innovations and redefine the boundaries of what is possible, paving the way for a future where technology seamlessly integrates into every aspect of our lives, enhancing our personal and professional experiences.

Many scholars have conducted research to demonstrate the limitations of current cultural protection measures, emphasising the need for more innovative and effective solutions. They have posited that the next generation of Internet technology, Web 3.0, can potentially promote a revolution in measuring and implementing cultural protection. Web 3.0, characterised by decentralised networks, blockchain technology, and enhanced user control, offers new avenues for preserving and protecting cultural heritage^[1-3]. By leveraging blockchain's transparency and immutability, cultural artifacts can be recorded and tracked with unprecedented accuracy, ensuring their provenance and safeguarding against illicit trade. Additionally, decentralised platforms can facilitate broader access to cultural resources, allowing communities to participate actively in conservation. This article explores how these Web 3.0 technologies can be applied to enhance the preservation of cultural heritage, examining potential applications such as digital archiving, secure transactions of cultural assets, and community-driven initiatives for heritage preservation, especially in a visualised way. Through this exploration, the article seeks to highlight the transformative potential of Web 3.0 in addressing the challenges of cultural conservation in the digital age.

2. Limitations of Current Cultural Heritage Conservation Methods

The importance of traditional culture in shaping a society's collective consciousness cannot be overstated. It bridges the past, present, and future, providing a sense of community continuity and identity. Corresponding with this perspective, there is an increasingly urgent need for innovative approaches to protect and preserve traditional culture, mainly intangible cultural heritage. This need arises from an appreciation of cultural diversity and from recognising traditional culture's critical role in sustaining social cohesion and transmitting valuable knowledge and skills from one generation to the next. However, as explored in this article's second part, traditional culture faces numerous threats in today's globalised and rapidly modernising world. The forces of globalisation, with its homogenising effects, can erode the uniqueness of local cultures. Modernisation often prioritises the new over the old, leading to the marginalisation of traditional practices. Additionally, the pervasive influence of Western culture through media, technology, and economic dominance can overshadow indigenous and traditional societies' value systems and lifestyles^[4]. Consequently, many aspects of traditional culture are currently at risk of being lost or relegated to the fringes of society.

Intangible cultural heritage, including oral traditions, rituals, craftsmanship, and performance arts, is uniquely vulnerable to various threats. These forms of heritage rely heavily on practice and oral transmission, making them particularly susceptible to disruptions in the transmission chains. Unlike tangible heritage, which can be physically preserved, intangible heritage exists within people's actions, skills, and memories, necessitating continuous and active participation from the community. One of the primary risks to intangible cultural heritage is the disruption of these transmission processes. Changes in societal structures, such as urbanisation, globalisation, and demographic shifts, can interrupt the intergenerational flow of knowledge and practices. For example, younger generations might migrate to urban areas for better opportunities, leaving behind the elderly custodians of these traditions. This migration can lead to a weakening or even a complete loss of collective memory within the community.

Additionally, social changes can dilute the communal engagement required to sustain these traditions^[5]. As communities evolve and adapt to modern influences, the traditional contexts in which these cultural expressions were performed and transmitted might lose their relevance or appeal, gradually eroding the practices. Without concerted efforts

to document, teach, and revitalise these traditions, the unique aspects of intangible cultural heritage risk being lost forever.

In response to these challenges, there is a growing movement to adopt new approaches to protect traditional culture. These approaches aim to be more inclusive, dynamic, and responsive to the needs of communities. They recognise that preservation efforts should not seek to freeze traditional culture in time but rather support its evolution and adaptation to contemporary contexts. This requires engaging with communities, understanding their aspirations, and respecting their right to determine the future of their cultural practices. For instance, one such approach is “living heritage,” which emphasises the continued use and reinvention of traditional culture in daily life. Instead of viewing artifacts, rituals, or customs solely as relics of the past, this perspective sees them as living entities that can adapt and grow. For example, traditional music can be performed in new contexts, attracting younger audiences while maintaining its essence. Traditional crafts can be incorporated into modern design, creating aesthetically contemporary products rooted in heritage. Another approach is digital documentation and dissemination. Technology offers powerful tools to record, store, and share intangible cultural heritage. Videos, audio recordings, and interactive platforms can capture the nuances of traditional practices and make them accessible to a global audience. This raises awareness and provides a resource for future generations to learn from and be inspired by.

Moreover, education also plays a vital role in this endeavour. Integrating traditional culture into school curricula and community programs can foster a deeper appreciation and provide younger generations with the skills and knowledge needed to carry these practices forward. This requires collaboration between educators, cultural practitioners, and community members to develop relevant and engaging materials. Furthermore, policymakers are responsible for creating an environment that protects traditional culture. This includes legislation that safeguards intellectual property rights, provides financial support for cultural activities, and develops mechanisms for communities to participate in decision-making. International conventions, such as the UNESCO Convention for Safeguarding the Intangible Cultural Heritage, offer frameworks for countries to recognise and support their intangible cultural heritage (2004)^[6].

Therefore, protecting traditional culture, mainly intangible cultural heritage, is crucial for preserving our global cultural diversity and the rich tapestry of human history. While conventional culture faces significant challenges from globalisation, modernisation, and external cultural influences, there is hope in new, community-centred approaches that emphasise the dynamic nature of living heritage. Digital technology, education, and supportive policies all have roles to play in ensuring that traditional culture remains an integral part of our lives, connecting us to our past, enriching our present, and shaping a diverse and inclusive future.

3. Next-Generation Internet Technologies Overview

Web 3.0, the next evolutionary phase of Internet technology, promises a paradigm shift towards a more decentralised, equitable, and user-empowered digital landscape. Web 3.0, also known as the “semantic web” or “decentralised web,” is expected to significantly improve the existing Internet ecosystem by addressing the issues of monopoly, lack of privacy protection, and malicious algorithms that plagued the Web 2.0 era. This new version of the Internet aims to create a more open, inclusive, and secure online space by using blockchain technology and artificial intelligence to enable machines to understand and process data more efficiently. At its core lie three fundamental characteristics: decentralised networks, blockchain technology, and heightened user control. These features are poised to revolutionise how we interact with digital content and hold significant potential for cultural heritage preservation.

With its distributed ledger capabilities, blockchain technology introduces unparalleled transparency and immutability to data recording. This makes it uniquely suited for applications such as tracking the provenance of cultural artifacts. Every stage of an artifact’s journey can be accurately documented by leveraging blockchain, creating a tamper-proof, verifiable, permanent record. This capability is invaluable for museums, archivists, and cultural institutions safeguarding history. With the ability to trace an object’s origin and authenticity, the potential for illicit trade and misattribution is significantly diminished. Decentralised networks address the vulnerabilities inherent in centralised control by distributing data across multiple nodes. This architectural approach enhances security by reducing the target size for potential attacks and ensures

resilience through redundancy. In the context of cultural heritage, information about artifacts, languages, traditions, and historical records can be stored and accessed resiliently and securely. The network continues functioning should any node fail or be compromised, safeguarding against losing irreplaceable cultural knowledge.

Enhancing user control is perhaps the most democratising aspect of Web 3.0. It empowers individuals and communities, giving them a voice and a vote in decisions that affect their cultural heritage. This increased participation fosters a more profound sense of ownership and engagement, leading to more extraordinary preservation efforts. For example, indigenous communities can now control how their stories and traditions are shared online, ensuring that cultural expressions are preserved and communicated with nuance and respect. Similarly, local historians and citizen archaeologists can contribute to a broader narrative by sharing their discoveries and insights, enriching the collective understanding of historical events. The transition to Web 3.0 also presents new opportunities for educational initiatives and cultural exchanges. Decentralised platforms can host virtual exhibitions and workshops where people worldwide can engage with cultural artifacts and experts without physical barriers. These interactions promote cross-cultural understanding and generate interest and support for cultural preservation efforts^[7].

Hence, Web 3.0's decentralised networks, blockchain technology, and enhanced user control offer a promising future for cultural heritage preservation. By harnessing the power of these technologies, we can create a digital ecosystem where cultural artifacts are securely documented, community involvement is paramount, and access to artistic education is widespread. With Web 3.0, individuals will have greater control over their personal data and digital assets, allowing them to enjoy the benefits of a more open and interoperable Internet. This new era of the Internet is expected to completely change how we interact online by empowering users and promoting decentralisation, ultimately forming a more equitable and democratic network ecosystem. For instance, if the function of Web1.0 could be described as “read,” then Web2.0 could be understood as “read + write,” and more significantly, the role of Web 3.0 is the Web of “read + write + own”^[8].

It is essential to a society's identity and heritage, providing a sense of belonging and continuity. It is significant for China's future Internet infrastructure construction and related industrial development to strengthen the forward-looking research and strategic prediction of Web 3.0. Along with technological development, how these technologies work on cultural heritage also becomes a question, especially traditional culture conservation, which will be discussed later. One of the key features of Web 3.0 is its ability to create a more intelligent and decentralised internet. This means that instead of relying on centralised authorities to control and manage the flow of information, individuals will have the power to control their own data and digital assets. This will make the internet more secure and private, as individuals can choose who can access their data and how it is used.

4. Methods of Applying Next-Generation Internet Technologies in Cultural Heritage Conservation in Visualised Ways

Preserving cultural heritage has always been a crucial aspect of our society. It helps us understand our past, shape our present, and guide our future. However, with the advent of digital technology, the way we preserve and access cultural heritage has undergone a significant transformation. Digital archiving is the process of converting physical artifacts into digital formats and storing them in a secure and accessible manner. This practice not only enhances the accessibility and longevity of cultural heritage but also ensures its authenticity and immutability. In this part, we will explore the definition and importance of digital archiving for cultural heritage, how blockchain technology provides the authenticity and immutability of digital records, and some examples of digital archiving using Web 3.0.

4.1. Digital Film and Television Production

Web 3.0 technology stands at the forefront of transforming the digital film and television production industry, ushering in an era of unparalleled efficiency, creativity, and cultural exchange. By leveraging cutting-edge technologies such as high-speed 5G networks and powerful cloud computing resources, production teams can now upload, edit, and render large

video files at unprecedented speeds. This technological leap expedites the production workflow and unlocks new realms of experimentation and innovation. Moreover, cloud computing has revolutionised how digital assets are managed and processed. Instead of relying on local servers with limited capacity, production companies can now utilise scalable cloud storage and computing power to handle the vast amounts of data generated during filming and post-production. Services like Amazon Web Services (AWS), Google Cloud, and Microsoft Azure provide robust platforms for storing, managing, and processing digital content. These platforms offer tools for rendering, editing, and distributing content, all accessible from any location with an internet connection. This flexibility allows teams to work more efficiently and reduces the need for costly physical infrastructure.

Integrating virtual and augmented reality (VR and AR) technologies, facilitated by Web 3.0, is another groundbreaking advancement in the industry. These immersive technologies allow filmmakers to create experiences that go beyond traditional storytelling. For instance, VR can transport audiences into fully realised virtual environments where they can interact with the story in previously unimaginable ways. This level of immersion is compelling in educational and cultural content, where audiences can explore historical events or far-off places with a sense of presence and immediacy. AR, on the other hand, enhances real-world experiences by overlaying digital content onto the physical world. This technology can be used in live broadcasts to add informative graphics, statistics, and other visual aids that enrich the viewing experience. For example, AR can be used during a historical documentary to superimpose historical artifacts or reconstructions over the current landscape, providing viewers with a deeper understanding of the subject matter.

These immersive technologies also encourage producers to create more culturally diverse content. By leveraging VR and AR, filmmakers can bring stories from different cultures to life in ways that resonate deeply with global audiences. This promotes cross-cultural understanding and broadens the scope of narratives, giving voice to underrepresented communities and perspectives. With Web 3.0, traditional film and television production bottlenecks are being cleared. The ability to swiftly transfer and process large volumes of data means that production timelines can be more efficient, reducing the time from concept to screen. This accelerated pace allows for greater flexibility in responding to market trends and viewer preferences, enabling creators to pivot and adapt their content strategies quickly. In addition, real-time collaboration has become possible across different geographical locations, breaking down the physical barriers that once limited creative teams. Directors, actors, and editors can work simultaneously on a project, regardless of location. This global collaboration fosters exchanging ideas and techniques that enrich storytelling, bringing together diverse talents and perspectives.

Furthermore, Web 3.0 technologies support the democratisation of content creation and distribution. Blockchain technology, another pillar of Web 3.0, offers new models for funding and distributing films. Decentralised platforms enable filmmakers to raise funds through cryptocurrency and smart contracts, bypassing traditional gatekeepers and reaching a global audience directly. This democratisation empowers independent filmmakers and smaller production houses, allowing them to compete on a more level playing field with larger studios. Integrating virtual and augmented reality technologies facilitated by Web 3.0 takes immersive experiences to a previously impossible level. Audiences can be transported into fantastical worlds or historical scenes with lifelike authenticity, enhancing their appreciation of different cultures and epochs. This technology encourages producers to create more culturally diverse content, promoting cross-cultural understanding on a global scale. As consumers become more discerning about their content, the ability to produce high-quality, culturally rich material will be a crucial determinant of success. Web 3.0 technology provides the tools to meet these demands, positioning the film and television industry at the forefront of cultural exchange and innovation.

To sum up, Web 3.0 technology is a tool for modernisation and a catalyst for profound change in the digital film and television production industry. It democratises the creation process, enables global collaboration, and facilitates immersive storytelling that celebrates cultural diversity. As we look to the future, Web 3.0 will continue to drive innovation, pushing the boundaries of what is possible in film and television production.

4.2. Blockchain and NFT

Blockchain technology and non-fungible tokens (NFTs) are revolutionising the preservation and monetisation of cultural

heritage. Traditionally, cultural heritage objects such as artworks, artifacts, and documents have been vulnerable to damage, decay, and fraudulent reproductions. However, a new era of safeguarding and valorising these assets has emerged with the advent of blockchain and NFTs.

At the core of this transformation lies blockchain's ability to provide an indelible and transparent record of ownership and provenance. Each transaction on a blockchain is secured by cryptography and linked to the previous one, creating an unbroken chain of custody that is tamper-proof and easily verifiable. This feature mainly benefits cultural heritage items, where provenance is crucial for determining authenticity and value. A digital ledger such as blockchain allows for every ownership transfer and historical event related to an object to be recorded and validated by multiple parties, thus ensuring its integrity and history are impeccably maintained.

Furthermore, NFTs issued on blockchain platforms offer a novel way to represent ownership of unique items, such as artworks or collectibles. Unlike fungible tokens like cryptocurrencies, which are interchangeable, each NFT is unique and carries exclusive ownership rights to the asset it represents. This means that artists and creators can issue NFTs representing their works, which buyers can then purchase and sell, maintaining a transparent and immutable record of ownership without the need for intermediaries. For instance, consider a renowned artist creates a limited series of digital artworks. Instead of selling these as traditional prints or digital files, the artist can issue NFTs representing each piece. Buyers can then purchase these NFTs, which are stored and verified on a blockchain, ensuring the authenticity and rarity of the artworks. As the owner of an NFT, a collector has verified proof of ownership recognised globally, facilitating the buying and selling of these unique items across borders and platforms.

The implications for cultural heritage preservation are profound. Not only does this ensure that items cannot be replicated without traceability, but also that the origins and histories of these artifacts are preserved in perpetuity. Even in disaster or loss of the physical item, the digital record remains intact, offering a conduit for restoration or replication based on irrefutable historical data. In addition, blockchain and NFTs open new revenue streams for cultural institutions and artists. Museums can tokenise their collections, offering exclusive experiences or pieces of history as NFTs for patrons to own and trade. This democratises access to cultural heritage, allowing anyone, anywhere in the world, to become a custodian of culture and history.

Therefore, blockchain technology and NFTs present a paradigm shift in preserving, verifying, and valuing our cultural heritage. By leveraging blockchain's immutable and decentralised nature and the unique representation of ownership that NFTs provide, we can protect our cultural legacy for future generations while creating new avenues for engagement and financial support for the arts and culture. The potential for this technology to transform the landscape of cultural heritage preservation and appreciation is immense, promising a future where our collective heritage is safer and more accessible to all.

4.3. Examples of Digital Archiving Using Web 3.0

Web 3.0 is a new generation of internet technology that is built on the principles of decentralisation, openness, and user empowerment. It offers a range of tools and platforms that can be used for digital archiving, including blockchain, smart contracts, and decentralised storage systems. Here are some case studies/examples of digital archiving using Web 3.0:

The European Collections Project: Aims to create a single access point for digitised cultural heritage collections across Europe. It uses Web 3.0 technologies such as linked data and open APIs to enable users to search, discover, and access millions of digital records from museums, libraries, and archives across the continent.

The Blockchain for Heritage Conservation Initiative: This initiative seeks to leverage blockchain technology to create a decentralised and transparent system for tracking the provenance and authenticity of cultural heritage objects. It involves the creation of a digital registry of objects, each with a unique digital signature or hash, that can be verified and updated by authorised parties using smart contracts.

The Internet Archive: This non-profit organisation aims to create a digital library of Internet sites and other cultural artifacts. It uses Web 3.0 technologies such as decentralised storage and peer-to-peer networking to create a distributed and

resilient archive that anyone with an internet connection can access.

According to these cases, it is notable that digital archiving is a critical practice for preserving cultural heritage in the digital age. It offers a range of benefits over traditional preservation methods, including enhanced accessibility, longevity, and authenticity. Blockchain technology, in particular, provides a robust solution for ensuring the authenticity and immutability of digital records, making it an ideal tool for digital archiving. With the emergence of Web 3.0 technologies, there is even more potential for innovation and collaboration in digital archiving, opening new possibilities for preserving and celebrating our cultural heritage.

5. Potential Challenges and Solutions

5.1. Technical and Logistical Issues

Integration with existing systems: Integrating Web 3.0 technologies into existing cultural heritage conservation systems poses significant technical and logistical challenges. Current systems in many cultural institutions are based on older technologies, which can make the adoption of new, decentralised Web 3.0 frameworks complex. For instance, blockchain technology, a cornerstone of Web 3.0, requires high interoperability with existing databases and management systems. This integration necessitates a comprehensive overhaul of current infrastructures, which can be resource-intensive and time-consuming. The complexity is further compounded by the need to ensure that all data is seamlessly transferred and remains accessible, secure, and intact throughout the process.

Scalability and maintenance: Scalability is another critical issue when applying Web 3.0 to cultural heritage conservation. Web 3.0 technologies, particularly blockchain, often struggle with scalability due to their decentralised nature, leading to slower transaction times and higher costs as the network grows. Additionally, the maintenance of these systems requires specialised knowledge and skills, which may not be readily available within the cultural heritage sector. Ensuring these systems remain functional and efficient as they scale up to accommodate a growing amount of data and increasing numbers of users is a significant logistical hurdle.

5.2. Ethical and Legal Considerations

Data ownership and privacy concerns: Web 3.0's emphasis on decentralisation and data ownership brings forth substantial ethical and legal considerations. In cultural heritage conservation, the data involved often includes sensitive information about artifacts, historical sites, and even personal data related to the provenance of items. Determining who owns this data and how it can be used, shared, or monetised without infringing on privacy rights is complex. There is a risk that decentralisation could lead to unauthorised access or misuse of sensitive information, undermining trust in the systems designed to protect cultural heritage.

Intellectual property rights: Intellectual property rights (IPR) present another challenge to cultural heritage. Web 3.0's decentralised platforms can complicate the enforcement of IPR, as they allow for easier replication and distribution of digital content without proper authorisation. This can lead to disputes over the ownership and use of digital representations of cultural artifacts. Protecting the intellectual property of cultural heritage while enabling access and engagement through Web 3.0 technologies requires a careful balance between openness and control.

5.3. Proposed Solutions

Developing standards and practices: Developing standards and best practices for integrating and using Web 3.0 technologies in cultural heritage conservation is crucial to addressing these challenges. These standards should ensure interoperability between old and new systems, facilitating a smoother transition. Best practices should focus on maintaining data integrity, security, and accessibility throughout the integration process. Furthermore, standardised protocols can help address scalability issues by providing efficient and effective system maintenance guidelines.

Collaborative frameworks and policy development: Establishing collaborative frameworks and developing

comprehensive policies are essential for mitigating ethical and legal concerns. Collaboration between cultural institutions, technology providers, policymakers, and legal experts can foster a shared understanding and approach to managing data ownership, privacy, and intellectual property rights. Policies should be designed to protect sensitive data and respect privacy while enabling the innovative use of Web 3.0 technologies. Additionally, legal frameworks must be updated to address the unique challenges posed by decentralised platforms, ensuring that intellectual property rights are upheld and enforced in the digital age.

Thus, while the application of Web 3.0 in cultural heritage conservation presents numerous technical, logistical, ethical, and legal challenges, these can be effectively addressed through the development of robust standards, best practices, and collaborative frameworks. By proactively tackling these issues, the cultural heritage sector can leverage Web 3.0 technologies to enhance the preservation, accessibility, and engagement with our shared cultural heritage.

6. Conclusion

In exploring the application of Web 3.0 technologies in cultural heritage conservation, we have examined both the potential benefits and the challenges inherent in this technological shift. Web 3.0, characterised by its decentralised frameworks, blockchain technology, digital archives, and enhanced data ownership capabilities, offers innovative solutions to some of the longstanding issues in cultural heritage conservation. However, this transition is not without its hurdles. This article discussed the technical and logistical challenges, such as integrating Web 3.0 with existing systems and addressing scalability and maintenance issues. Furthermore, we delved into ethical and legal considerations, including concerns about data ownership, privacy, and intellectual property rights. To address these challenges, we proposed developing standards and best practices alongside establishing collaborative frameworks and policies to ensure the responsible and effective use of Web 3.0 technologies in this field.

The integration of Web 3.0 into cultural heritage conservation represents a significant opportunity to enhance the preservation, accessibility, and engagement with our shared cultural heritage. While the benefits of Web 3.0 are substantial, including increased data security, transparency, and decentralisation, the path to fully realising these benefits is fraught with challenges. By identifying and addressing these challenges through developing robust standards, best practices, and collaborative policies, the cultural heritage sector can effectively harness the potential of Web 3.0 technologies. Such technologies have the potential to revolutionise the field of cultural heritage conservation. The decentralised nature of blockchain can offer unparalleled data security and transparency, ensuring that records of cultural artifacts are immutable and traceable. This can significantly reduce the risks associated with data tampering and loss, thereby enhancing the integrity and trustworthiness of cultural heritage databases. Moreover, the ownership capabilities embedded in Web 3.0 technologies empower communities and individuals by giving them greater control over their cultural data. This can facilitate more inclusive and participatory approaches to heritage conservation, where local communities play a central role in managing and preserving their cultural assets. By leveraging smart contracts, cultural institutions can create new, secure ways to manage and distribute digital rights and royalties, ensuring that cultural heritage creators and custodians are properly compensated and recognised.

However, integrating Web 3.0 into cultural heritage conservation is not straightforward. The significant technical and logistical challenges, such as ensuring seamless integration with existing systems and managing scalability, require substantial investment in technology and training. Institutions must be prepared to invest in upgrading their technological infrastructures and developing the necessary skill sets among their staff. Moreover, ethical and legal considerations are crucial in this transition. Protecting data privacy and intellectual property rights in a decentralised environment demands new regulatory frameworks and policies. These frameworks must balance the openness and accessibility of Web 3.0 with the need to safeguard sensitive information and uphold the rights of cultural stakeholders.

To navigate these complexities, a multi-faceted approach is essential. Developing comprehensive standards and best practices will provide a roadmap for institutions to follow, ensuring that the integration of Web 3.0 is conducted

systematically and effectively. Additionally, fostering collaborative frameworks involving cultural institutions, technology providers, policymakers, and legal experts will be critical in creating a supportive environment for this transition. Hence, while the application of Web 3.0 in cultural heritage conservation presents both opportunities and challenges, the potential benefits far outweigh the hurdles. By proactively addressing the technical, logistical, ethical, and legal challenges, the cultural heritage sector can leverage Web 3.0 technologies to create a more secure, inclusive, and dynamic future for cultural heritage conservation. Through thoughtful and collaborative efforts, we can ensure that our shared cultural heritage is preserved, enriched, and made more accessible for future generations.

Disclosure statement

The author declares no conflict of interest.

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