Blockchain as digital memory:
Documenting crimes against cultural heritage during armed conflicts

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Abstract. In the contemporary world, armed conflicts pose a threat not only to human lives, but also to cultural heritage, which serves as crucial evidence of the history and identity of nations. Research into the potential of blockchain technology draws attention to its capabilities in preserving evidence of cultural heritage and crimes committed against it during military conflicts, particularly in the context of the Russian-Ukrainian war. This study aimed to analyse the use of blockchain technology for documenting crimes against cultural heritage, focusing on its potential for long-term preservation, authentication of digital evidence, ensuring open access to records, and supporting digital memory at a national level. The research methodology combined general scientific methods – analysis, synthesis, abstraction, logical exposition, and generalisation – with specialised research methods, including bibliographic analysis, content analysis, and critical approaches. Blockchain is a distributed ledger (or database) composed of a chain of blocks, each containing specific information. The potential of blockchain technology can be harnessed to document crimes against cultural heritage, particularly in the context of the Russian-Ukrainian war. This involved: preserving digital evidence of crimes, creating a register of lost heritage, decentralising archival data, securing international recognition of facts of criminal destruction, and facilitating crowdfunding and funding for restoration. Existing blockchain initiatives, such as Salsal, Monuverse, and Ukraine DAO, by transforming cultural heritage into an interactive digital resource, can become tools for documenting criminal damage, preserving memory, countering illicit trafficking of artefacts, and establishing a novel form of resilient digital documentation in wartime. The practical significance of the research lies in the use of blockchain for preserving the heritage of Ukraine and other countries experiencing cultural losses due to war. This is crucial for ensuring digital memory, transparency, and the legal reliability of information for subsequent legal prosecution and historical accountability for crimes against heritage in Ukraine

Keywords: digital preservation of evidence; protection of cultural property; digital technologies; international documentation standards; data decentralisation

Introduction

UNESCO and other international organisations have attempted to address the issue of documenting crimes against cultural heritage, notably through databases and websites. Accurate documentation of cultural heritage status was therefore essential for its protection and for conducting scientific research during restoration and renewal processes (Yastikli, 2007). However, these structures were as vulnerable as the cultural and historical assets they were intended to document.

The 2020s saw an increase in the use of blockchain technology and NFTs (non-fungible tokens) across various societal sectors, including economics, information technology, and art. While blockchain was most frequently associated with cryptocurrencies, its properties of immutability and durability have drawn

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the interest of archives, libraries, museums, and galleries. This interest particularly pertained to its potential benefits in the context of developing and promoting approaches and protocols for improving the management and documentation of digital cultural and historical heritage. M. De Santo *et al.* (2017) noted that contemporary challenges included the consequences of technological transformations, specifically changes in rights, ownership, and responsibility concerning cultural heritage, taking into account evolving forms of access to and new manifestations of digital heritage. S. Lvping (2021) indicated that, while blockchain cannot replace existing database technology, it was often employed as a supplementary technical tool in combination with other technologies. N. Zoannos *et al.* (2023) noted that this offered the potential to ensure the continuity of heritage for future generations by creating a decentralised global network among stakeholders to facilitate its preservation and worldwide dissemination. D. Buragohain *et al.* (2024) stated that the use of blockchain was important not only in connection with the rapid progress of globalisation and modernisation, which constantly threaten historical artefacts and commemorative sites globally, but primarily during periods of significant uncertainty, military conflicts, and systemic risks that jeopardise destruction or damage. This also necessitated the punishment of perpetrators and compensation for damages to lost cultural resources.

Researchers abroad have actively investigated the possibilities of blockchain technology in managing digital heritage. J. Zhang *et al.* (2021) explored the specificities of the process of transporting cultural relics, which required special risk prevention mechanisms. The authors presented a real-time management system for transporting cultural relics using Internet of Things terminals and blockchain technology. A detailed example of the system's application during the transportation of cultural relics from the Changsha Museum to the Museum of the Nanyue King of the Western Han Dynasty was described by the authors.

Scholars L. Zhao *et al.* (2023) constructed a cryptographic interaction method, the Museum Art Exchange Protocol (MAXP), for museum digital collections based on blockchain technology. They created a digital collection exchange system on Ethereum to facilitate online exchange between two museums, which helped to avoid risks caused by subjective and force majeure factors in the digital collection exchange process, such as hackers and network viruses. This could promote the exchange of collections between museums and holds significant importance for the popularisation of cultural heritage and the dissemination of scientific knowledge. Authors N. Zoannos *et al.* (2023), focusing on the implementation of the UNESCO 2003 Convention for the Safeguarding of Intangible Cultural Heritage, considered how blockchain can ensure its preservation by creating a decentralised network among stakeholders.

Using a systems approach, the authors described the process of placing a new element into Greece's repository to demonstrate to UNESCO the necessity of a clearly defined process, which needs to be followed worldwide, and which was yet to be established. In doing so, the authors addressed a series of questions: what difficulties arise in determining the type and selecting the best metadata model for use in each specific case during collection; what technologies should be used for storing digital cultural heritage, presenting a challenge to physical and technological threats. Authors H. Stublić *et al.* (2023) analysed the research of other authors from 2017-2022 concerning the application of blockchain and NFTs in the field of cultural heritage. Specifically, the scholars highlighted the topics reviewed, as well as proposed models and projects. The second part of the article discussed use cases for the technology, identified unexplored topics warranting further study, and aimed to bring the potential of blockchain and NFT technology closer to experts in the cultural heritage sector.

In Ukrainian scholarship, blockchain technology has also established a significant presence. Several researchers have mainly focused on exploring its application in the cultural and artistic sectors. I. Spodenets & O. Zhukova (2022), based on a review of blockchain application experience, outlined its potential uses in the sphere of immovable cultural heritage, particularly fortification architecture. They documented the experience of successful use of NFT tokens in the Ukrainian museum and cultural sector and the experience of forming a crypto-heritage market. The scholars highlighted perspectives for cooperation between representatives of cultural and creative industries and individual territorial communities regarding the preservation, popularisation, and capitalisation of Ukrainian fortification heritage through the creation of NFT tokens. K. Ishchenko (2024) analysed the main stages of formation and characteristics of non-fungible tokens with a projection onto their use in the cultural and artistic sphere. The author also sought to substantiate the importance of applying NFTs for the preservation of cultural values, the authorship of works of art, and the creative industries. L. Krestyanpol *et al.* (2023) examined blockchain technology as used for NFTs, including the development of a unique collection of digital assets and their placement on a marketplace. This research was aimed at creating a blockchain-based system for the protection of cultural heritage. It can be stated that researchers were interested in the possibilities of blockchain for documenting and preserving cultural heritage, particularly in the context of transparency, authenticity, and traceability of artefacts, including the recording of crimes committed against them.

This study aimed to determine the possibilities of using blockchain technologies for preserving digital archives of cultural heritage that has been destroyed or was under threat of destruction in conditions of

global instability, as well as for documenting crimes against it during military conflicts. The scientific novelty was that this was the first time in Ukrainian documentation studies that the potential of blockchain technology for documenting crimes against cultural heritage has been substantiated.

Materials and Methods

The interdisciplinary nature of the research subject necessitated the use of a range of methods and approaches integrated from various fields of scientific knowledge: documentation studies, social communications, digital management, information technologies, and history.

General scientific methods, including analysis, synthesis, abstraction, logical exposition, and generalisation, enabled a thorough exploration of the topic and the achievement of the study's aim. The bibliographic method involved a systematic analysis of scholarly literature on the research topic, which allowed for the identification of key concepts, definitions, and theoretical approaches. Works from related fields of knowledge, such as museum technologies and art expertise, were examined, contributing to the formation of a comprehensive view of the problem. The content analysis method was applied for a deeper study of the content of scholarly publications and official documents. Key analytical categories were identified, such as technological aspects of blockchain and NFTs, documentation of crimes against cultural heritage, and digital archives, which facilitated the structuring of the obtained data and the identification of patterns within the research topic. The historical method was used to synthesise previous theoretical and practical developments; the structural-systemic approach was employed to define the features of blockchain for its application in documenting crimes against cultural heritage. Triangulation of methods and sources occurred by comparing data obtained from different research approaches, which allowed for a reduction in the risk of subjective interpretations. For example, the results of the content analysis were compared with conclusions drawn from the bibliographic method, and different scholarly viewpoints were considered to achieve greater reliability in the generalisations.

The research was conducted in several interconnected stages. The first stage involved clarifying the scientific directions: the research topic was studied, which allowed for characterising its multidisciplinary nature and integrating knowledge from various fields for a more comprehensive analysis. An analysis of methods and approaches was conducted: methods and approaches were considered taking into account the specifics of the research, its aims, and object; the justification for the choice of methods: emphasis was placed on the necessity of obtaining scientifically grounded and representative results, which was crucial for the reliability of the conclusions.

In the second stage, scientific methods were selected, the research plan was developed, and the collection of information commenced, utilising existing studies and examining the results of scholars' activities. This stage was used for analysing and systematising existing materials and research findings, defining the scientific context of the research, and evaluating the modern state of theoretical and practical developments to form a scientific understanding of blockchain and its potential for documenting crimes against cultural heritage.

In the third stage, the information obtained from scholarly and practical sources was processed and analysed. Taking into account the historical method and the method of generalisation, the methods of abstraction and specification, as well as the structural-systemic approach, the main features of blockchain were identified. These features allow for asserting its advantages and developing a theoretical model for its application in documenting cultural heritage that was damaged, illegally displaced, or under threat of destruction as a result of military conflicts. The fourth stage involved formulating the research results using methods of synthesis, generalisation, and concretisation, while also adhering to the principle of reliability. In the fifth stage, potential directions for the future development of blockchain technology in documenting and protecting cultural heritage were proposed, along with prospects for further academic research in this aspect.

Results and Discussion

The idea of documenting cultural heritage during military conflicts to preserve evidence about it belongs to the Austrian-Bosnian architect, artist, and Massachusetts Institute of Technology (MIT) professor Azra Akšamija. She was known for her research at the intersection of architecture, art, and the humanities in the context of cultural heritage, migration, and religious identity, as well as for projects aimed at preserving cultural heritage and developing design in crisis conditions (for refugees and displaced persons). As A. Akšamija emphasised in her analysis of the Balkan Wars and conflicts in the Middle East, the desire to destroy the cultural and historical achievements of the aggression's victim was linked to heritage being the material and most readily understandable evidence of a people's distinctiveness, demonstrating that a specific ethnic community has resided in a certain territory for a long time (Machado, 2016). Therefore, the aggressor developed a motivated desire to eliminate all information about their victim's rich past.

A. Akšamija became the creator of a large-scale art and architecture project titled Memory Matrix, which she realised in 2016 together with students on the Massachusetts Institute of Technology (MIT) campus (Fig. 1). Its goal was to address the problem of cultural heritage destruction in Syria, Iraq, Yemen, and other countries. The project became part of research on

preserving cultural heritage in conditions of conflict and destruction, and emphasised that memory can be preserved even, when physical objects disappear. Memory Matrix was a part of the broader Future Heritage Lab initiative, which A. Akšamija founded to work with refugees, preserve culture, and implement innovations in architecture. Memory Matrix took the form of a gigantic screen installation shaped like a large lattice structure made of chain, containing thousands of small plexiglass pixel elements. It reproduced the image of the Triumphal Arch in Palmyra (Syria), which was destroyed by ISIS (Islamic State of Iraq and Syria) terrorists in 2015. The backlighting made the structure appear virtual, as if hinting at the fragility of memory.
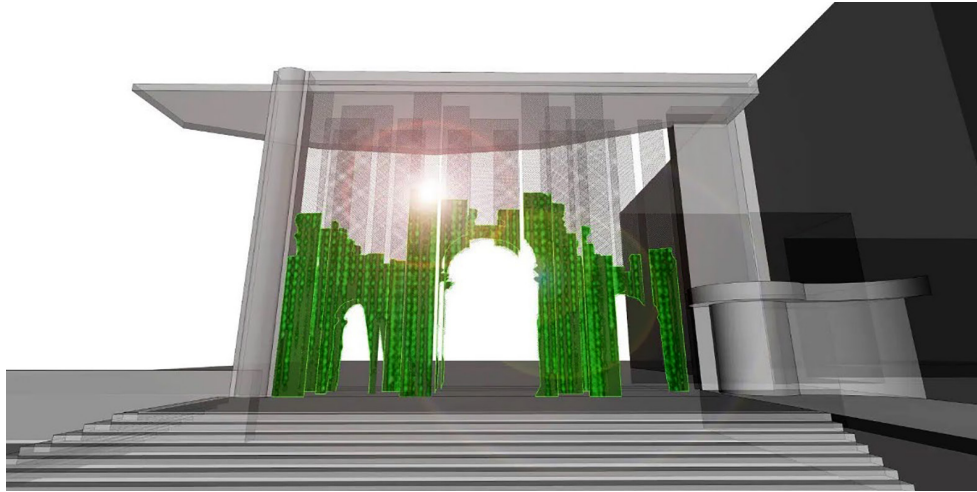

Figure 1. Project Memory Matrix

Source: based on S. Machado (2016)

The elements were cut in the middle using a laser so that they took the shape of fragments of cultural heritage (acrylic pixels resembling small amulets) that were under threat or have vanished due to wars and conflicts. The cut-out fragments have been transformed into jewellery and sold to fund educational workshops conducted by the institute's students for Syrian refugees in Jordan, Germany, and Austria. Each plexiglass ornament, positioned within the pixels, was inscribed into the "cultural memory of participants" and also encoded on the blockchain so that only the author can control it (Fig. 2). Thus, one of the innovative features of this project was the use of blockchain to preserve digital data about destroyed culture.
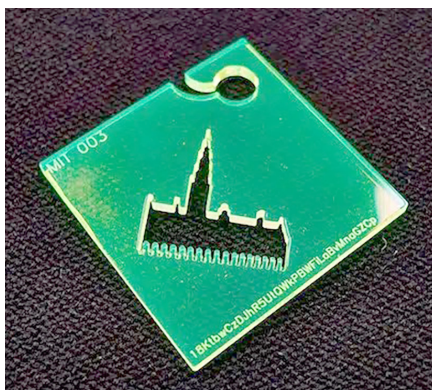
Thanks to blockchain, each pixel (element, amulet) of the installation can be linked to a unique digital record that stores historical, cultural, or personal data. The owner of a pixel can confirm ownership of the ornament using a linked private key, which can also be used for signing and authentication (Fig. 3). Furthermore, the public can use the public key to encrypt messages that only the owner can decrypt. With a cryptographic heritage, the key owner can preserve cultural value, demonstrate ownership, transmit messages, and leave evidence about it in the world. The data recorded on the blockchain can be scanned or viewed via QR codes on the installation. This creates a connection between the physical space of the installation and digital memory, which exists independently of physical destruction. In addition to architectural data, the system was also able to accommodate the personal stories of refugees and testimonies about the loss of cultural heritage. They can add their stories or memories to this digital archive, creating a collective cultural resource. This project was not merely an artistic installation, but also an experiment in creating "digital memory" that existed independently of physical space. It combined architecture, art, technology, and the humanities to combat oblivion and losses resulting from war, effectively documenting crimes against cultural and historical memory. The project also demonstrated how blockchain can become a tool for preserving history and collective memory, serving as a foundation for new initiatives that used technology to protect and document crimes during military conflicts.
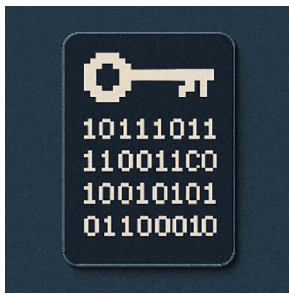

Figure 2. Acrylic pixel ornament
Source: based on S. Machado (2016)

Figure 3. Stylised image of a key with digital elements
Source: based on S. Machado (2016)

Overall, within this technology, various scientific disciplines intersect, necessitating the development of fundamental algorithmic approaches, making them critically important areas of focus for artificial intelligence innovation (de Regt, 2020). Therefore, it was worth examining the main aspects of initiatives using blockchain for documenting crimes against cultural heritage more thoroughly, as blockchain and NFTs can help preserve and promote the visibility of important cultural artefacts, notably due to qualities such as non-fungibility and security. The greatest advantage of blockchain in a crisis situation was the secure signing of messages and the entry of immutable information into a global database (Machado, 2016). Blockchain provided a history for a monument, meaning protection of information about it from manipulation and interference, which was critically important in conflict conditions. Once information was recorded on a blockchain, it cannot be altered or deleted. Blockchain was also used for: authentication (verifying the authenticity of a work or its cultural value through digital authenticity as a guarantee that the digital resource was original and has not been altered), tracking (the ability to follow the origin and history of a cultural resource over time, as each transaction related to the heritage was recorded on the blockchain, creating its complete history), managing rights for digital cultural works, which increased transparency and reduces fraud, and the "non-fungible nature of blockchain ledgers significantly minimises the risk of counterfeiting" (Boiko & Maksymov, 2023).

A large database was replicated across thousands of computers (nodes) of varying power and capacity, which share the same software (protocol) to communicate with each other. The shared protocol verifies and confirms transactions, guaranteeing their integrity and permanence over time. Information related to a transaction was copied to thousands of nodes. As G. Bustos Pretel (2018) pointed out, this ensures the system's reliability, as it was possible to manipulate one or a few computers, but not thousands.

Through tokenisation, a cultural resource can be converted into digital non-fungible tokens (NFTs) –

a unique digital asset, "a phenomenon of not only virtual, but also modern culture in general" (Machulin, 2022) – which represented ownership of a cultural work and through which it can be bought or sold, and its preservation conditions recorded and controlled. L. Krestyanpol *et al.* (2023) stated that NFTs "offer a promising solution for managing and authenticating digital assets. Cultural assets are transformed into unique digital items using NFT technology"**.**

Improved access to cultural heritage contributes to the creation of verified digital platforms, where it can be securely accessed. As a result, everyone can become "a participant and manager of a new cultural and artistic reality, which is characterised by global trends and local features of the production, development, popularisation, and circulation of cultural values" (Ishchenko, 2024). In terms of contributing to restoration and renewal, blockchain can assist in the future recreation and rebuilding of destroyed sites, which not only facilitated efficient management of cultural resources, but also their long-term preservation. Blockchain provided shared access to data and resources, enabling the documentation and tracking of the restoration process, the formation of a set of rules and processes that defined how decisions were made within the network. This allowed multiple parties to work transparently and securely, facilitating communication and collaboration on projects. Thus, common methods and approaches can be developed for cataloguing procedures, methods of storing records, and metadata models used during the documentation, visualisation, and preservation of cultural heritage elements, which currently differ significantly from country to country (Zoannos *et al.*, 2023). Furthermore, blockchain facilitated fundraising through crowdfunding and the issuance of tokens. Importantly, transactions were conducted directly, without intermediaries (Blockchain in cultural heritage…, n.d.). F. Valeonti *et al.* (2021) indicated that this aspect was one of the main features of using the technology and has enabled the resolution of the increasingly growing financial problems of cultural heritage preservation.

Decentralised management was carried out by all connected computers rather than a single entity, ensuring data storage within the network and precluding the possibility of destruction or censorship by any organisation or state. This facilitated the creation of collective ownership and meaningful, linked digital objects, enabling the country or individual communities to play a significant role in cultural heritage management (Liddell, 2021). Scholars Y.-C. Wang *et al.* (2021) stated that digital rights management was a mechanism that protected digital content from misuse by controlling and managing its usage rights. Consequently, citizens can actively participate in the creation and management of records and rights, as there was no central authority controlling the network, and all participants have equal access. All of this has created a new memory

ecosystem, whereby communities were invited to contribute, participate, and share a greater proportion of what they were collectively interested in remembering, rather than simply accepting authoritative narratives from institutions (Burkey, 2021).

A. Akšamija's idea effectively initiated an innovative approach to documenting crimes against cultural heritage during military conflicts. Her initiative used blockchain technology to create a decentralised, immutable archive capable of storing data about cultural artefacts and other important evidence, including their destruction or damage resulting from military actions. However, among the crimes against cultural heritage, besides destruction and damage, there was another aspect that often accompanies military conflicts – the illegal displacement of cultural artefacts. Abu Dhabi scholar A. Khelifi and archaeologist M. Altaweel developed a blockchain tool for authenticating cultural artefacts called Salsal or Agur. It enabled museums and collectors to verify the authenticity and provenance of tangible cultural resources, which can protect collections and create an immutable database of historical objects. The service established a transparent and reliable history of a collection's origin and eliminated the risks associated with using items that have been removed (illegally displaced, stolen). Using Salsal, a global database of artefacts can be created, which would make it possible to track their journey from their initial location to a museum, auction house, or even a collector's home. Additionally, Salsal promoted the accessibility of cultural objects and information about them for a wide audience. Thus, this tool enabled objects, either individually or as part of broader collections, to be verified for compliance with ethical and legal requirements, while simultaneously providing users with relevant information. This can be used to incentivise or even pressure collectors or museums to verify their objects, which can benefit the public (Khelifi *et al.*, 2024). Overall, this could prevent the illegal sale or displacement of artefacts and encourage collectors to return stolen items. However, the success of Salsal was directly dependent on the collectors themselves, who need to be encouraged to use the platform.

During the Russian-Ukrainian war, blockchain can become a powerful tool for documenting crimes against cultural heritage thanks to its key properties, which were manifested in several functions (Table 1).

Table 1. Blockchain as a tool for documenting crimes against cultural heritage

Functions of blockchain technology	Features of the application	Consequences for recording crimes
Preservation of digital evidence	Photographs, videos, satellite images, and other evidence of heritage condition can be uploaded to the blockchain	Allows crimes to be time-stamped, preventing their forgery or destruction; the use of InterPlanetary File System (IPFS) in conjunction with blockchain enables decentralised storage of large files
Creation of a registry for lost heritage	NFTs can be created for each cultural heritage object, with its history stored on the blockchain, from initial state to destruction and restoration	Serves as evidence of war crimes and assists in subsequent reconstruction
Decentralisation of archival data	Blockchain technology can be used to create distributed databases	Ensures the preservation of information even in the event of the physical destruction of central servers and archives
International recognition of criminal destruction facts	Blockchain enables the creation of a public registry, accessible to researchers, forensic experts, UNESCO, the UN, and other organisations	Assists in documenting crimes for future legal proceedings
Crowdfunding and restoration financing	Smart contracts can be used for fundraising	Facilitates the reconstruction of destroyed monuments. For example, NFT projects can direct funds towards the restoration of specific objects

Source: compiled by the author

Such a comprehensive approach not only protected historical memory, but also made it more difficult for the aggressor to deny their crimes by documenting them on the blockchain. Ukrainian researcher A. Kravchenko (2023) emphasised the necessity of engaging all digital tools for culture creation and potential case studies to preserve national cultural and artistic heritage "...in conditions of hybrid threats and military interventions (similar to those currently experienced by Ukraine)". Furthermore, it was worth considering the blockchain initiatives Monuverse and Ukraine DAO, whose examples could be adapted for the tasks of documenting crimes against cultural heritage in Ukraine.

Monuverse was a blockchain project that preserved digital copies of cultural landmarks within the metaverse. Its primary objective was to provide access

to important architectural and cultural objects in the virtual world through interactive 3D models created using virtual and augmented reality technologies. Each landmark or architectural object was digitised in minute detail to preserve it for future generations. This included not only the exterior appearance of buildings, but also internal interiors, architectural elements, mosaics, and other important details. The digitisation of landmarks was a way to preserve them in the event of criminal damage or natural disasters. The initiative became accessible to the public through the Monuverse crypto art project. Monuverse's first NFT release of 7777 tokens across seven artefact levels focused on the 2021 Ouchhh Arch of Peace installation. Each release from Monuverse was termed an "episode", covering limited edition NFT instances with ongoing benefits for owners and institutions. Through the use of blockchain, Monuverse ensured the authenticity and security of the digital copy: each record about a landmark became immutable and transparent (Fig. 4).

Figure 4. 2021 Ouchhh Arch of Peace installation

Source: based on E. Kostina (2022)

Within Monuverse, tokens can be used for buying and selling digital assets, for example, to raise funds for the preservation or restoration of cultural heritage. Thanks to such innovations, Monuverse has the potential not only to make cultural landmarks accessible in the digital world, but also to contribute to the development of a global community that cares for them. The platform believed that sharing knowledge about both local and international landmarks was a means to help local institutions preserve or restore them, and through the sale of NFTs, to improve funding sources for relevant activities (Kostina, 2022).

In Ukraine, a blockchain initiative already existed for fundraising in support of the country – the decentralised autonomous organisation Ukraine DAO. Its main objective was fundraising and supporting various humanitarian initiatives and projects related to the war in Ukraine, including aid for refugees, those affected by the war, and contributing to the country's reconstruction (Ukraine DAO, n.d.). Ukraine DAO also actively used cryptocurrencies for fundraising and transferring aid. This reduced barriers for international donors and accelerated the process of transferring funds without relying on traditional banking systems. Funds raised from NFT sales and other activities were directed towards financing humanitarian missions, providing aid in the form of medical supplies and food, securing temporary housing for refugees, and supporting other initiatives.

Founded on 21 February 2022, Ukraine DAO utilised Web3 and an online community to counter Russian disinformation, promote Ukrainian culture, and document war crimes. The initiative assisted the Starling Lab (Stanford + USC) Project Dokaz in documenting Russian crimes collected by their team in Kharkiv. These were submitted by partners to the International Criminal Court as part of the world's first cryptographic dossier, preserving evidence of Russian war crimes in a manner that no one, not even Russia, can forge. This will help to ensure justice for Ukraine (Project Dokaz..., n.d.). Despite criticism regarding the community's activities concerning "organisational structure, opaque fund distribution, and centralised control over them" (Oliynyk, 2024), Ukraine DAO stands as an excellent example of how Web3 technologies such as blockchain, cryptocurrencies, and NFTs can be used for global support of humanitarian initiatives and aid in crisis situations, including in the context of crimes against cultural heritage. One of the most widely recognised elements of Ukraine DAO became its collection of NFTs for fundraising to support Ukraine. One of the initial NFT projects was the sale of a symbolic Ukrainian flag, which served as a sign of the global network supporting the country on the international stage during the war.

Thus, blockchain technologies opened up new possibilities for protecting cultural heritage, ensuring transparency, immutability, and shared access to data. They enabled the documentation of site destruction,

the tracking of artefact authenticity, and contributed to their preservation and restoration. Decentralised platforms encouraged public participation in heritage management processes, creating a new memory ecosystem. In the context of war, this was particularly crucial for recording crimes and preventing the illegal displacement of cultural property.

Conclusions

Blockchain is a distributed, decentralised database (ledger) consisting of a sequential chain of blocks, each containing data and a cryptographic link to the previous block. It ensured the security, immutability, and transparency of stored information without the need for centralised management. The advantages of using blockchain in the preservation, protection, and documentation of crimes against cultural heritage included: immutability and security, improved access to cultural heritage, facilitation of restoration and renewal, decentralised access, preservation of digital evidence of crimes, creation of a register of lost heritage, decentralisation of archives, international recognition of facts of crimes, and crowdfunding and funding for restoration.

The use of blockchain, NFTs, and digital archiving made it possible to create immutable databases that ensured the authenticity and accessibility of information about cultural artefacts, as well as to track the provenance and history of a cultural resource over time, since every transaction related to heritage was recorded on the blockchain. This increased transparency, reduced illegal displacement, and the recording of destruction preserves evidence of war crimes, which increased the

country's chances of defending its rights in various international institutions. Therefore, the greatest advantage of this technology was not only its cryptographic tools and distributed system, but the decentralised immutability of data within a network, where users may often be distrustful of one another's actions. All these advantages of blockchain can be utilised in documenting crimes against cultural heritage during the Russian-Ukrainian war.

Existing blockchain technologies such as Salsal, Monuverse, and Ukraine DAO can become tools for documenting criminal damage with the aim of preserving data about cultural landmarks during the war. By transforming heritage into an interactive digital resource, they opened up new horizons for its protection, documenting crimes against it, and preventing the illicit trafficking of artefacts. The combination of cultural and artistic resources with modern technologies created a new form of documentary memory that was capable of actively resisting the destruction and forgetting of a people's history.

Future research should focus on in-depth thematic and empirical studies to understand the practical implications of using blockchain for documenting crimes against cultural heritage resulting from military conflicts, specifically within the realities of the Russian-Ukrainian war.

Acknowledgements

Conflict of Interest

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Блокчейн як цифрова пам'ять: документування злочинів проти культурної спадщини в умовах воєнних конфліктів

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Анотація. У сучасному світі збройні конфлікти загрожують не лише людським життям, а й культурній спадщині, яка є ключовим свідченням історії та ідентичності народів. Дослідження, визначення та обґрунтування можливостей технології блокчейну привертає увагу до її можливостей у збереженні доказів культурної спадщини та злочинів проти неї в умовах військових протистоянь, зокрема російсько-української війни. Мета дослідження – проаналізувати можливості використання технології блокчейн для документування злочинів проти культурної спадщини, зокрема в контексті довготривалого збереження, автентифікації цифрових свідчень, забезпечення відкритого доступу до них та підтримки цифрової пам'яті національного рівня. Методологія дослідження ґрунтувалася на поєднанні загальнонаукових – аналізу, синтезу, абстрагування, логічного викладу, узагальнення, та спеціальних методів дослідження – бібліографічного, контент-аналізу, критичного підходу. Блокчейн – це розподілений реєстр (або база даних), яка складається з ланцюжка блоків, які містять певну інформацію. Можливості блокчейн-технології можна використати для документування злочинів проти культурної спадщини, зокрема в умовах російсько-української війни. Це передбачало: збереження цифрових доказів злочинів, створення реєстру втраченої спадщини, децентралізацію архівних даних, міжнародне визнання фактів злочинних руйнувань, краудфандинг та фінансування відновлення. Наявні блокчейн-технології, як-от Salsal, Monuverse та Ukraine DAO, трансформуючи культурну спадщину в інтерактивний цифровий ресурс, можуть стати інструментом для документування злочинних руйнувань, збереження пам'яті, протидії незаконному обігу артефактів і створення нової форми стійкої цифрової документації в умовах війни. Практичне значення дослідження полягає у використані блокчейну для збереження спадщини України та інших країн, які зазнають культурних втрат через війну. Це важливо для забезпечення цифрової пам'яті, прозорості та юридичної достовірності інформації для подальшого правового переслідування та історичної відповідальності за злочини проти спадщини в Україні

Ключові слова: цифрове збереження доказів; захист культурних цінностей; цифрові технології; міжнародні стандарти документування; децентралізація даних