

**INTELLIGENCE, SECURITY
AND INTERDISCIPLINARITY**

THE ROLE OF ARTIFICIAL INTELLIGENCE IN PREVENTING DIGITAL TRAFFICKING OF CULTURAL ARTIFACTS

Alexandra NICOLESCU*

Abstract:

The adaptation of cultural crimes to the digital environment has enabled terrorist groups and criminal networks to exploit online platforms, social media and encrypted applications for the illicit trafficking with cultural artefacts. This article explores how artificial intelligence may contribute to preventing and disrupting digital trafficking of cultural objects. The research explores how emerging technologies, such as image recognition, metadata analysis and algorithmic mapping tools, can contribute to the identification and monitoring of these crimes.

The aim of this research is to assess the capacity of artificial intelligence to detect suspicious transactions and support investigations, as well as to analyse the legal and technological barriers that limit its application. The study adopts an interdisciplinary approach that integrates legal, technological and cultural perspectives, and proposes innovative solutions to enhance the effectiveness of these technologies.

The findings show that artificial intelligence can play an important role in protecting cultural heritage, though its impact is limited by incomplete databases, the fragmentation of information, and confidentiality matters. At the same time, collaboration between experts and algorithms, along with the implementation of federated learning, can enhance both the efficiency and the credibility of AI-based solutions.

Keywords: *cultural terrorism; illicit traffic; artificial intelligence; international legislation; funding sources; digital commerce.*

Introduction

At present, the illicit trafficking and trade of cultural artefacts has become a serious threat to international security and the preservation of the world's cultural heritage. These illicit activities have evolved from being primarily associated with private collectors and art markets to

* PhD student in Security Studies and International Relations, Babes-Bolyai University, Cluj-Napoca, email address: alexandranicolescu9718@gmail.com

serving as a significant source of funding for terrorist groups (Kersel and Gerstenblith, n.d.).

The fight against the illicit trafficking and trade of cultural artefacts is now a priority for the international community, leading to legal and political initiatives and to the exploration of technological solutions. In this context, artificial intelligence is recognized as a strategic tool in international efforts to prevent and combat the illicit trade of cultural property.

This research seeks to analyse the role of artificial intelligence (AI) in preventing and combating the digital trafficking of cultural artefacts.

The objectives of this study aim to:

1. Examine how artificial intelligence can be applied to detect suspicious online activities and track cultural artefacts sold online.
2. Review the international legal framework on digital trafficking of cultural property and assess the contribution of AI to prevention efforts.
3. Identify the main challenges and limitations in implementing artificial intelligence tools in this field and to suggest innovative ways to improve the use of these technologies.

This study adopts an exploratory qualitative approach, based on the analysis of secondary sources related to the fields of cultural heritage protection, transnational crime and emerging technologies. The research uses a documentary method, which includes identifying, selecting and critical interpretation of information from scholarly literature, international legislation, institutional reports and investigative journalism.

The research draws on a variety of sources, including scholarly studies from the international academic literature, articles from the international press and normative acts issued by global organizations.

The issue of digital trafficking of cultural objects has been highlighted both in press articles and in international academic research, which has documented the use of social networks, encrypted applications and online marketplaces for the promotion and sale of illicit goods. However, academic studies have only recently started to address the technological dimension of these cultural crimes and the use of

artificial intelligence to prevent and combat the digital trafficking of cultural artefacts remains insufficiently explored.

In this context, the study aims to offer a clearer picture of AI's role in countering digital trafficking of cultural heritage, by examining both its potential benefits and the obstacles that may hinder its effective use.

This study makes a contribution by connecting legal and technological perspectives. It highlights the gaps in legislation regarding the digital trafficking of cultural artefacts and the absence of clear policy guidance on the use of artificial intelligence in this area.

Through this approach, the article offers a framework for critical reflection on the integration of artificial intelligence into the mechanisms for safeguarding cultural heritage, emphasizing the need for cooperation between cultural institutions, legal authorities and digital platforms.

Digital mechanisms for trafficking cultural goods

Contemporary society is shaped by technology and widespread internet access, factors that have profoundly reshaped social, economic and cultural structures. Information systems are ubiquitous and influence every dimension of daily life, while the rapid circulation of information has transformed the modern world into a knowledge society, often referred to as an information society (*Library, Information and Society*, 2024).

The Internet has become the main driver of the information society, providing rapid access to resources and removing traditional communication barriers. Its ease of use and global reach have made it indispensable, leading to an exponential increase in the number of users.

This evolution has redefined social and economic relations, profoundly influencing the power structure, education and decision-making processes, thus creating a new way of organizing and functioning in the modern world (Băjenescu, 2006).

Technological advancements have radically transformed the mechanisms of illicit cultural artefact trafficking and have facilitated the rapid and anonymous distribution of looted or stolen cultural goods. In addition, the Internet offers global access, secure platforms for transactions and encrypted communication channels, which make it

difficult to monitor, prevent and combat illicit practices with antiquities (Amineddoleh, 2015).

As the above being mentioned, a significant side effect of technological progress is the adaptation of illicit trafficking with cultural objects to the global digital infrastructure. This type of transnational crime does not only affect directly the universal cultural heritage, but has also consolidated itself as a financing mechanism for organized crime networks and terrorist groups (UNESCO, 2025).

According to the specialized literature, illicit trafficking and trade with cultural artefacts represents one of the most profitable black markets worldwide, generating annual revenues of billions of dollars and involving a complex network of actors and transactions that are difficult to trace (Willett, 2016).

Illicit trafficking of cultural goods encompasses the export or unlawful transfer of artefacts in contravention to national or international laws. Such activities are frequently motivated by commercial gain or exploited to finance criminal networks and terrorist organizations, underscoring the critical link between cultural crimes and global security concerns (UNESCO, n.d.).

In the context of technological development, social networks have become basic channels for illegal transactions involving cultural artefacts. Traffickers exploit the facilities offered by these media – anonymity, encrypted communication, global visibility – to promote, negotiate and sell cultural goods to potential buyers, in a framework lacking institutional supervision and clear regulation (Mashberg, 2020).

In the specialized literature, the use of the Internet by terrorist groups for propaganda, recruitment, planning attacks or money laundering has been intensively documented and analysed. However, the dimension aimed at obtaining financial resources through digital trafficking and trade with cultural artefacts remains insufficiently investigated, despite the increasing evidence regarding the use of digital infrastructure to monetize cultural heritage stolen from conflict zones (Todorovic and Trifunovic, 2020).

This research gap leaves in the shadows an emerging financing mechanism that eludes the traditional framework for investigating

terrorism and organized crime, but which benefits from the same cybernetic advantages: anonymity, decentralization and lack of regulation.

In the online environment, the illicit trafficking of cultural artefacts represents a continuation of traditional smuggling, adapted to the digital space, where criminal networks exploit technological vulnerabilities to finance their activities.

Online platforms provide distribution networks with the ability to expand rapidly and access the international market with ease, while at the same time reducing the risks associated with the physical transportation of artefacts. Within these networks, information about cultural goods is often compartmentalized, anonymized and disguised, allowing direct contact with buyers and transactions with minimal risk of exposure (Suárez-Mansilla, 2018).

A relevant example of the cyber dimension of the illicit trafficking and trade of antiquities is the use of the social network Facebook as a tool for promoting, selling and even organizing criminal activities. While Facebook was initially a simple means of uploading and sharing photos and videos, the platform now offers advanced features such as live streaming, video chat and encrypted messaging, which facilitate illegal transactions and communications between traffickers (Azm and Paul, 2018).

Although the first forms of digital trafficking through social networks were observed ever since 2011, the phenomenon gained significant breadth after 2014, following the intensification of the actions of the Islamic State, which orchestrated the systematic looting of archaeological sites in Iraq and Syria. The Islamic State turned cultural heritage into a dual resource: a source of funding and a tool for propaganda. This strategy marked the beginning of a new era in terrorist financing, driven by the illicit trafficking and trade of antiquities (Azm and Paul, 2018).

Thus, Facebook has become a space for interconnection between local looters located in different conflict zones, such as: Libya, Yemen, Syria, Iraq, and potential buyers from all over the world. Through its own algorithms, the platform facilitates not only the rapid promotion of cultural goods, but also their authentication through crowdsourcing and the efficient dissemination of illicit information. In this way, this platform

has been transformed into a digital space conducive to the rapid dissemination of illicit information and the facilitation of commercial contacts between actors involved in the trafficking of artifacts (Azm and Paul, 2023).

A relevant example is the ATHAR project (Antiquities Tracking and Heritage Anthropology Research Project), which identified ninety-five Facebook groups involved in the illicit trafficking of cultural artefacts. These groups operated under three levels of confidentiality: public, closed and secret, of which twenty-eight were public, sixty-five closed and two secret. This highlights the way these networks operate in an environment that is partially or completely opaque (Azm and Paul, 2019).

The closed structure of these groups facilitated the operation and expansion of illicit activities, while also allowing for their rigorous control. In some cases, group administrators required potential members to pay a search fee, the so-called *khums tax*. This fee system, initially established by the Islamic State, indicates both a form of self-financing as well as a continuity of the ideological and logistical network that, although physically destroyed, has transformed and adapted itself to the digital environment (Azm and Paul, 2019).

Although Facebook has banned the sale of looted cultural goods, the enforcement of these policies has been fragmented and ineffective, being left largely to users, who could report suspicious content. In the absence of a specialized moderation team capable of assessing the provenance and authenticity of cultural artefacts, these notifications have not had a substantial impact.

Furthermore, following an investigation by the BBC and public pressure from experts such as Professor Al-Azm and his colleagues, Facebook decided to remove forty-nine groups involved in the illicit trafficking of antiquities, which highlighted another serious vulnerability, namely the lack of a protocol for preserving and sharing digital data (Swann, 2019). By directly deleting the content, valuable evidence for official investigations was lost, which undermines international efforts to dismantle the networks involved (Zraick, 2019).

In this context, in the absence of clear protocols for sharing data with the competent authorities, social networks become a space of digital

impunity and the responsibility of digital platforms is minimized, with traffickers benefiting from reduced visibility and minimal operational risks (The European Institute for International Relations, 2022).

Although online platforms have added cultural artefacts to the list of prohibited items alongside with drugs and weapons, this measure remains ineffective without clear mechanisms for monitoring and compliance (Azm and Paul, 2023). The lack of cultural expertise within moderation teams and the absence of systematic cooperation with law enforcement hinder the effective implementation of these rules, allowing the illicit trade to persist online.

In the digital environment antiquities traffickers employ advanced technique to conceal their identity and avoid detection. These include falsifying photo metadata, using crypto currencies for anonymous payments and employing proxies or VPNs to mask their location.

Photo metadata contains information about the date, time and location where the photograph was taken. These data, known as EXIF (Exchangeable Image File Format) can be modified and/or removed by traffickers to conceal the origin of artefacts and prevent the identification of their actual location. Manipulating metadata hinders investigations and makes it difficult to trace the path of cultural objects from their source to the market (Awati and Sheldon, 2024).

The manipulation of photo metadata is not explicitly addressed to in the literature on illicit trafficking of cultural artefacts, however it is a well-documented practice in other illicit activities, such as human trafficking (United Nations Office on Drugs and Crime [UNDOC], n.d.).

This gap underscores the significant challenges faced by authorities in detecting and combating this concealment method employed by traffickers to facilitate the illicit trade of cultural artefacts.

As for crypto currencies, they offer a high degree of anonymity to illicit transactions involving cultural artefacts, making them a favourite choice for traffickers due to the difficulty of monitoring such payments. They are used by both buyers and sellers because they (Sargent et al., 2020):

- guarantee transaction confidentiality and prevent the tracking of financial flows,
- eliminate the involvement of financial institutions that might report suspicious transactions,

- facilitate fast and unrestricted cross-border fund transfers.

Traffickers take advantage of digital tools that provide anonymity in the online environment. In the online trafficking of cultural goods, VPN (Virtual Private Networks) networks and proxy servers are frequently used to conceal the identity and true location of those involved (Fraudlogix, n.d.).

These tools mask the IP address, which significantly hinders the efforts of authorities to identify and locate suspects. Although the specialized literature does not explicitly address to the use of these technologies in the trade of cultural artefacts, their application is well-documented in other illegal activities due to high level of confidentiality they provide (Harrison, 2018).

Similar to practices in human trafficking and terrorist financing, these mechanisms are likely used in this context to shield criminal networks and terrorist groups from detection and prosecution (Bing, 2016).

The escalation of digital tactics employed by criminal networks, from metadata manipulation to identity concealment through VPNs and crypto currencies, highlights the limitations of traditional investigative methods. This situation requires the development of innovative solutions capable of adapting to the dynamics of the cyberspace. Artificial intelligence is emerging as one of the most effective solutions for identifying the illicit trafficking of cultural artefacts.

Artificial Intelligence - a mechanism to prevent illicit trafficking

Relying on the points discussed above, we consider the use of artificial intelligence (AI) in combating the illicit trafficking of cultural artefacts to represent a significant advancement in detecting, preventing and countering of illegal activities aimed at generating financial resources for terrorist groups.

This technology enables the rapid and efficient analysis of large amounts of data, facilitating the identification of suspicious cultural objects and the continuous monitoring of illicit activities conducted in the online environment (Abate et al., 2023).

Artificial intelligence (AI) can be used in several ways to prevent and combat illicit trafficking with antiquities, including:

The automatic identification of suspicious cultural artefacts is carried out by AI systems through the use of visual recognition, comparative analysis and metadata analysis, each method contributing to the verification of the artefacts authenticity and provenance.

Visual recognition and comparative analysis are complementary in the identification of suspicious cultural artefacts. Visual recognition extracts the distinctive features of artefacts, such as shape, texture, ornamentation and inscriptions, and converts them into digital profiles (Patias and Georgiadis, 2023)

Deep learning algorithms, particularly convolutional neural networks (CNN) analyse these features to compare the cultural objects with international database, such as those maintained by INTERPOL or UNESCO, identifying discrepancies that may indicate forgery or illicit provenance (Winterbottom et al., 2022).

Comparative analysis utilizes digital profiles generated through visual recognition to evaluate suspicious objects against authentic cultural artefacts in international databases. By comparing visual features, such as shape, texture, colour and inscriptions, the system identifies similarities that confirm authenticity, as well as subtle discrepancies that may indicate forgery or illicit provenance.

In parallel, the analysis of associated metadata provides additional information that contributes to verifying the credibility of the artefact. By correlating visual data with metadata, comparative analysis becomes an effective tool for the rapid identification of suspicious cultural objects and for supporting law enforcement agencies in their efforts to safeguard cultural heritage.

Monitoring online sales and social media has become essential in preventing the illicit trafficking of cultural artefacts. E-commerce platforms and social networks are increasingly used for trading such items, providing traffickers with the ability to communicate anonymously and conceal their identity, which significantly complicates the detection of illegal transactions (Swann, 2020).

To counter these practices, artificial intelligence-based systems employ natural language processing (NLP) techniques to analyse object

descriptions, messages and comments associated with online posts (Ferro et al., 2025).

The algorithms identify terms, ambiguous expression, or coded language used in illicit trade, such as indirect references to archaeological artefacts, geographic locations, or historical periods. In addition, NLP detects semantic anomalies, including discrepancies between descriptions and images or the absence of provenance information.

This textual analysis is combined with visual recognition of images to correlate the language used with the characteristics of the cultural objects. In parallel, the analysis of associated metadata enables the identification of locations, transaction histories and connections between suspicious accounts (Ünver, 2023).

By integrating these methods, artificial intelligence systems can rapidly detect suspicious accounts, communication patterns and transactional networks, thereby supporting authorities in investigating and preventing illicit trafficking. This combined approach provides a comprehensive and effective tool for protecting cultural heritage (Abate et al., 2023).

The analysis and mapping of criminal networks represent an advanced tool employed by artificial intelligence (AI) to combat the illicit trafficking of cultural artefacts. By collecting and correlating data from suspicious transactions, geographic locations, online interactions and users' profiles, artificial intelligence can construct dynamic maps of criminal networks, highlighting connections between actors who appear to be independent (Adán and Loureiro, 2023).

By using Social Network Analysis (SNA) and Machine Learning (ML) algorithms, behavioural patterns that indicate illegal activities can be identified. These algorithms monitor the frequency of specific terms or expressions, activity times and days, encrypted payment methods and unexpected price fluctuations (Giovannelli and Traviglia, 2024).

By detecting these patterns suspicious accounts or transactions can be highlighted, enabling authorities to focus on high-risk elements and anticipate traffickers' strategies.

Furthermore, artificial intelligence applies anomaly detection techniques to identify hidden connections between accounts and

transactions by analysing IP addresses, transaction histories and users' interactions (Komenchuk, 2025). This information enables the reconstruction of criminal network structures, highlighting illicit flows and identifying central nodes – the individuals or entities that play a key role in coordinating and organizing the cultural trafficking (Malinverni, et al., 2024).

In view of the above, we recall the European project SIGNIFICANCE, which employs machine learning algorithms to monitor suspicious transactions on the Internet and Dark Web. The importance of this projects lies not only in its technical capacity but also in its ability to demonstrate how AI technologies can support authorities in anticipating and mapping criminal networks. At the same time, it highlights the necessity of institutional collaboration and the development of interoperable databases to enhance the effectiveness of such systems (Abate et al., 2022).

The analysis of the specialized literature highlights the fact that the efficiency of these technological tools is conditioned by certain essential factors, among which we mention: access to extensive, updated and interoperable databases, as well as international collaboration between law enforcement authorities, cultural institutions and international organizations.

A crucial step in enhancing the effectiveness of artificial intelligence in combating the illicit trafficking of cultural artefacts is the integration with international databases, such as those maintained by UNESCO, INTERPOL or digital museum collections.

By connecting artificial intelligence systems to international databases, the authenticity of cultural artefacts circulating online can be verified in real time. When a cultural object is posted on a digital platform, visual recognition algorithms analyse its physical characteristics, such as shape, dimensions, texture, decorations and inscriptions, and convert them into digital profiles (Patiás and Georgiadis, 2023).

Furthermore, the metadata associated with images and the descriptions of artefacts are automatically cross-referenced with information from official databases UNESCO, INTERPOL, or museum collections. Any discrepancy, such as unverified provenance, incorrect dating or differences in dimensions and visual characteristics, is detected

immediately. This automated correlation enables the rapid identification of potential forgeries, trafficked cultural objects or suspicious transactions, providing authorities with an effective means to prevent and combat the illicit trafficking of cultural goods (Daskalakis et al., 2024).

This continuous analysis allows AI systems to alert authorities immediately when suspicious artefacts appear in the digital environment. This way, monitoring shifts from a reactive process to a proactive process. Moreover, real-time verification facilitates the rapid correlation of cultural objects with transactions, accounts and criminal networks involved, providing a comprehensive picture of illicit activities (Daskalakis et al., 2024).

Thus, through integration with international databases and the utilization of the aforementioned technologies, artificial intelligence emerges as a strategic tool capable of optimizing both prevention and intervention in the protection of international cultural heritage.

Challenges and limitations in the use Ai for preventing and combating the digital trafficking in illicit artefacts

The integration of artificial intelligence into the prevention and combat of illicit trafficking of cultural artefacts involves a series of technical, ethical and legal challenges and limitations, which require careful analysis to evaluate the effectiveness and feasibility of these technologies.

From a technical perspective, the integration of artificial intelligence technologies into the processes of identifying, authenticating and monitoring cultural goods trafficked online shows considerable potential promise (Zhan, 2025). Nevertheless, the effectiveness of these solutions depends directly on the quality of the data, the stability of the algorithms and their capacity to operate in complex digital environments. Without a careful understanding of these challenges, prevention strategies risk losing their effectiveness or even generating unintended consequences.

A primary challenge in applying artificial intelligence to the prevention of digital trafficking of illicit cultural artefacts is related to the limited availability and low quality of data. Machine learning models, particularly those based on deep learning, require substantial volumes

of visual and contextual data to recognize patterns, distinguish authentic cultural artefacts from forgeries and identify subtle indications of illicit provenance (Winterbottom et.al. 2022).

In the field of cultural heritage, data are often fragmented (for example: museum collections cover only a fraction of the relevant cultural assets, photographs vary in resolution and quality, and metadata concerning provenance or conservation status are frequently incomplete or inconsistent). This fragmentation leads to reduced sensitivity and increases the error rate (Foka et. al., 2025).

It is worth noting that most existing datasets include artefacts from well-documented historical periods or civilizations, while cultural objects associated with lesser-known or insufficiently researched civilizations are underrepresented. This unequal distribution of data can introduce structural bias into artificial intelligence algorithms, leading them to more easily recognize cultural objects derived from well-documented civilizations, while rare or less-known artefacts are identified with lower accuracy (Liu et al., 2025).

Thus, algorithmic biases in artificial intelligence systems are configured as follows: models trained on limited, unbalanced or poorly labelled datasets tend to reproduce distortions of the available information (Zhan, 2025). These algorithmic biases can be amplified by the way data is processed: inconsistent labelling, lack of terminological consensus among institutions or the arbitrary removal of less clear records. This leads to systematic errors in the learning process (Foka et. al., 2025).

Deep-learning-based AI models, such as convolutional neural networks, which have been predominantly trained on a particular class of cultural artefacts or on images acquired under ideal conditions, tend to underperform when they encounter artefacts originating from different historical periods, styles, acquisition angles, illumination conditions or states of degradation (Antun et al., 2020).

The scholarly literature underscores the challenges of metadata inconsistency and insufficiency associated with cultural artefacts. Core descriptors such as geographical provenance, chronology, materials or conservation status are frequently incomplete or recorded in heterogeneous schemas, which complicates metadata interoperability

and hinders the correlation of information on provenance, authenticity and transaction history (Liu et al., 2025).

The absence of unified standards for structuring and harmonizing metadata terminology leads to a loss of accuracy and stability in artificial intelligence models, thereby limiting their capacity to effectively support the prevention and combat of illicit trafficking in cultural property.

The issue of data scarcity encompasses dimensions related to the quality, consistency, diversity and accessibility of information. In the absence of a coordinated strategy for data collection, data cleaning and harmonization, the potential of artificial intelligence in preventing and combating the digital trafficking of illicit cultural property is undermined and the results risk being partial or discriminatory.

Another challenge in applying artificial intelligence to the prevention of digital trafficking in cultural heritage objects is data confidentiality. Machine learning algorithms rely on access to a wide range information, such as transaction records, data concerning the location of artefacts or the individuals involved, and images extracted from online platforms in order to rapidly detect suspicious cultural property (Zhan, 2025). However, the processing of such data risks relates both to the privacy of the individuals involved and to the management of cultural sensitivity associated with certain cultural assets.

The large-scale processing of data entails the risk of disclosure and misuse of personal data by malicious individuals or entities, as well as the exposure of sensitive information concerning the provenance and location of cultural heritage objects (Mademlis, 2024).

The excessive collection of data about users or legitimate sellers may violate data protection legislation, such as the General Data Protection Regulation (GDPR), and may undermine the trust of stakeholders involved in the management of cultural heritage (Zhan, 2025).

The protection of personal data is essential; however, overly restrictive or fragmented regulations may limit the access of artificial intelligence systems to the information necessary for detecting and preventing digital trafficking of cultural objects. At the same time, the lack of a coherent approach at the international level can generate legal uncertainty and additional costs for organizations developing solutions

dedicated to the protection of cultural heritage, thereby discouraging their large-scale implementation (Zhan, 2025).

These difficulties highlight the importance of harmonizing confidentiality requirements with the need for access to relevant data for artificial intelligence systems. Thus, a clear and coherent regulatory framework at both national and international levels can support the responsible processing of information, ensuring respect for fundamental rights as well as the effectiveness of technological solutions.

To understand the legal challenges concerning the use of artificial intelligence in combating the digital trafficking of artefacts, it is necessary to examine the evolution of the international legislative framework.

Since 2015, the systematic destruction and looting in Iraq and Syria have highlighted the link between cultural crimes and the financing of terrorism (Terlinden, 2023). Consequently, the international community has adopted legislative measures and global policies to prevent and combat the destruction, looting and trafficking of cultural property, thereby elevating the protection of cultural heritage to a strategic security objective (United Nations Office on Drugs and Crime [UNDOC], 2016).

Although numerous journalistic investigations, specialist reports and academic studies highlight the fact that cultural artefacts are actively promoted, sold and traded on digital platforms – including through social networks, encrypted applications and online marketplaces – the digital component of trafficking with cultural goods continues to be ignored in the regulatory context.

Following the analysis of the international legislative framework, the European Union's Action Plan against the trafficking of cultural goods, adopted in 2022, stands out as it explicitly recognizes the potential of emerging technologies, such as artificial intelligence and aerial surveillance, in identifying and preventing the illicit trade in cultural artefacts (European Commission, 2022).

Given that this is the only legislative document that refers to the potential of artificial intelligence, without providing a concrete implementation framework for the European Union member states, we aim to identify and evaluate how global policies address to the role of artificial intelligence in the prevention and combat of digital trafficking of illicit cultural property.

At the international level, a series of policies aimed at regulating and applying artificial intelligence have been adopted and implemented. In 2019, the Organization for Economic Cooperation and Development (OECD) launched the Principles on Artificial Intelligence, the first major intergovernmental set of major guidelines dedicated to the governance of this technology (Russo; Oder, 2023). These principles, of a recommendatory nature (soft law), promote five essential directions: inclusive and sustainable growth, respect for human rights and democratic values, transparency and explainability, robustness and security, as well as accountability (OECD, n.d.).

With regard to the protection of cultural heritage, these principles do not directly refer the fight against illicit trafficking of artefacts carried out online. These can be interpreted as a foundation for the ethical use of AI technologies in the process of verifying the provenance and authenticity of cultural objects.

Nevertheless, the absence of practical mechanisms and of an approach specific to the cultural field makes it difficult to directly apply the principles in the domain of cultural heritage protection.

In 2021, UNESCO adopted a global recommendation establishing a universal ethical framework for the development and use of artificial intelligence. The document promotes values such as fairness, transparency, respect for human rights and cultural diversity (UNESCO, 2023).

From the perspective of cultural heritage protection, these principles can guide the implementation of AI applications aimed at artefacts or the monitoring of suspicious digital transactions.

However, the recommendation remains a soft law instrument, lacking legally binding force and without providing concrete tools for application in the context of digital artefacts trafficking, which limits its immediate impact.

In 2024, the AI Act was adopted as the European Union's first legally binding legislative framework regulating the use of artificial intelligence. Its purpose is to protect fundamental rights, ensure transparency and accountability and strengthen trust in emerging technologies (European Commission, n.d.).

Although the Act does not directly address the cultural sector or the issue of digital trafficking of artefacts, the principles and standards it

establishes for high-risk AI systems can serve as a significant regulatory benchmark.

This is explained by the fact that the AI Act introduces clear requirements for transparency, auditability and security, establishes accountability obligations for developers and users and endures the harmonization of regulations across the European Union (European Commission, n.d.).

All of these elements can be extrapolated to the field of cultural heritage protection, providing a general legal framework that could underpin sectorial policies dedicated to the prevention and combat of digital trafficking of illicit cultural goods.

These global policies on artificial intelligence provide an increasingly clear framework for the responsible use of this technology in the prevention and combat of digital trafficking of illicit cultural artefacts. Nevertheless, their application remains challenging, as certain legal systems do not accept algorithm-generated data as valid evidence unless accompanied by transparency and auditability (Fair Trials, 2022). This highlights the need to develop transparent and auditable AI solutions that are compatible with the evidentiary requirements of legal systems.

This evidentiary obstacle is represented by the normative gap resulting from the absence of international legislation governing digital trafficking of illicit cultural artefacts. Furthermore, global policies on artificial intelligence governance do not provide support for the use of this technology in the prevention and combat trade of illicit cultural property. These gaps reduce the effectiveness of a coordinated response and highlight the need for an integrated legislative framework that harmonizes the rules concerning cultural heritage with those dedicated to innovative technologies.

Possible solution for improving the prevention and combat of digital trafficking in illicit antiquities

The review and analysis of technical, ethical and legal challenges have highlighted that, in the absence of corrective measures, the potential of artificial intelligence in preventing and combating digital trafficking of illicit cultural objects risks to remain fragmented and insufficiently harnessed. Nevertheless, these limitations outline future directions

for the development of innovative solutions capable of combining technological efficiency that complies with legal and ethical standards.

Federated learning constitutes an innovative approach to overcoming challenges related to data privacy and data accessibility through the collaborative training of artificial intelligence models. This mechanism enables algorithms to be trained on distributed datasets across multiple institutions, such as museums, online platforms, customs agencies and law enforcement authorities, without raw data being transferred or exposed to security risks (Gong et al., 2024).

Thus, a balance is established between the need to access substantial volumes of information and the requirement to comply with data privacy regulations. Moreover, through the decentralized aggregation of information, artificial intelligence systems become more robust and less dependent on the idiosyncrasies of a single dataset, thereby mitigating the risk of algorithmic bias (Huang et al., 2024).

Federate learning addresses the challenges of privacy-preserving data protection while enabling broader access to relevant datasets. Nevertheless, its applicability remains limited in analytical contexts that require context-dependent semantic interpretation of cultural, legal and historical dimensions.

Therefore, the actual effectiveness of technological tools emerges when they are complemented by the expertise and discernment of domain specialists, a synergy that can strengthen efforts to prevent and combat digital trafficking of illicit cultural property. To ensure technical accuracy as well as the probative validation of results, collaboration between humans and artificial intelligence becomes indispensable. Although algorithms can detect subtle anomalies in metadata, suspicious transactions or cultural objects with uncertain provenance, only specialists can validate and correctly interpret these data and transform them into credible legal evidence (Adán and Loureiro, 2023).

The integration of automation with human expertise supplies a balanced framework of action, in which technology provides speed and the capacity to process large volumes of data, while specialists ensure rigorous interpretation and the prevention of errors and misuse of results. In the absence of such a partnership, risks increase considerably, either through excessive reliance on opaque algorithms or through the

significant slowdown of investigations conducted exclusively via manual verification (Abate et al., 2022).

Thus, a well-structured collaboration between humans and artificial intelligence enhances the effectiveness of detecting, preventing and combating digital trafficking of illicit cultural artefacts, while simultaneously providing safeguards for the observance of legal and ethical principles (Malinverni et al., 2024).

The development of specialized algorithms tailored to the specific characteristics of cultural artefacts represents another key factor in leveraging artificial intelligence for cultural heritage protection. General-purpose models, which are trained on large-scale datasets, fail to capture the subtle details associated with cultural artefacts (Kaldeli, 2023). This shortcoming leads to classification errors and generates confusion between authentic and falsified cultural objects.

Training algorithms on diversified and contextualized collections would enable more accurate recognition of cultural objects and a more precise differentiation between authentic artefacts and sophisticated forgeries (Malinverni et al., 2024).

At the same time, the integration of historical (Daskalakis et al., 2024) and legal metadata (such as provenance documentation, ownership history and applicable legal regime) into these modules would add a valuable evidentiary dimension (Kaldeli, 2023).

This way, the results generated by artificial intelligence would not be limited to mere visual classification but could be used as support in legal investigations and provenance verification processes. Such an approach would enhance the credibility and auditability of digital evidence, reinforcing its value in both legal and cultural contexts.

Conclusions

The findings of this study underscore the complexity and dynamism nature of digital crimes involving illicit cultural artefacts. While artificial intelligence has proven to be a valuable instrument for the monitoring and preventing of such cultural offenses, its potential is constrained by critical factors such as data incompleteness, information fragmentation and the ethical and legal dilemmas associated with data privacy.

This study also highlighted the existence of a regulatory gap: at present, the international legal framework does not directly regulate the cyber dimension of cultural trafficking, nor the application of emerging technologies in the prevention and combat of such illicit activities.

The prevention and combat of digital trafficking of illicit cultural artefacts cannot be addressed solely from a technological or legal perspective. Although algorithms and AI-based processes can handle large volumes of data with a speed unattainable by human experts, they cannot substitute for human judgment and the expertise required for the interpretation and validation of results.

Therefore, only through a solid partnership between human expertise and digital tools can both the efficiency of detection and the legal value of evidence be ensured.

In conclusion, a sustainable synergy should be made in which artificial intelligence is complemented by adapted ethical standards and public policies. Through such complementarity, artificial intelligence can fully realize its potential, becoming a strategic instrument in the fight against digital cultural crime.

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